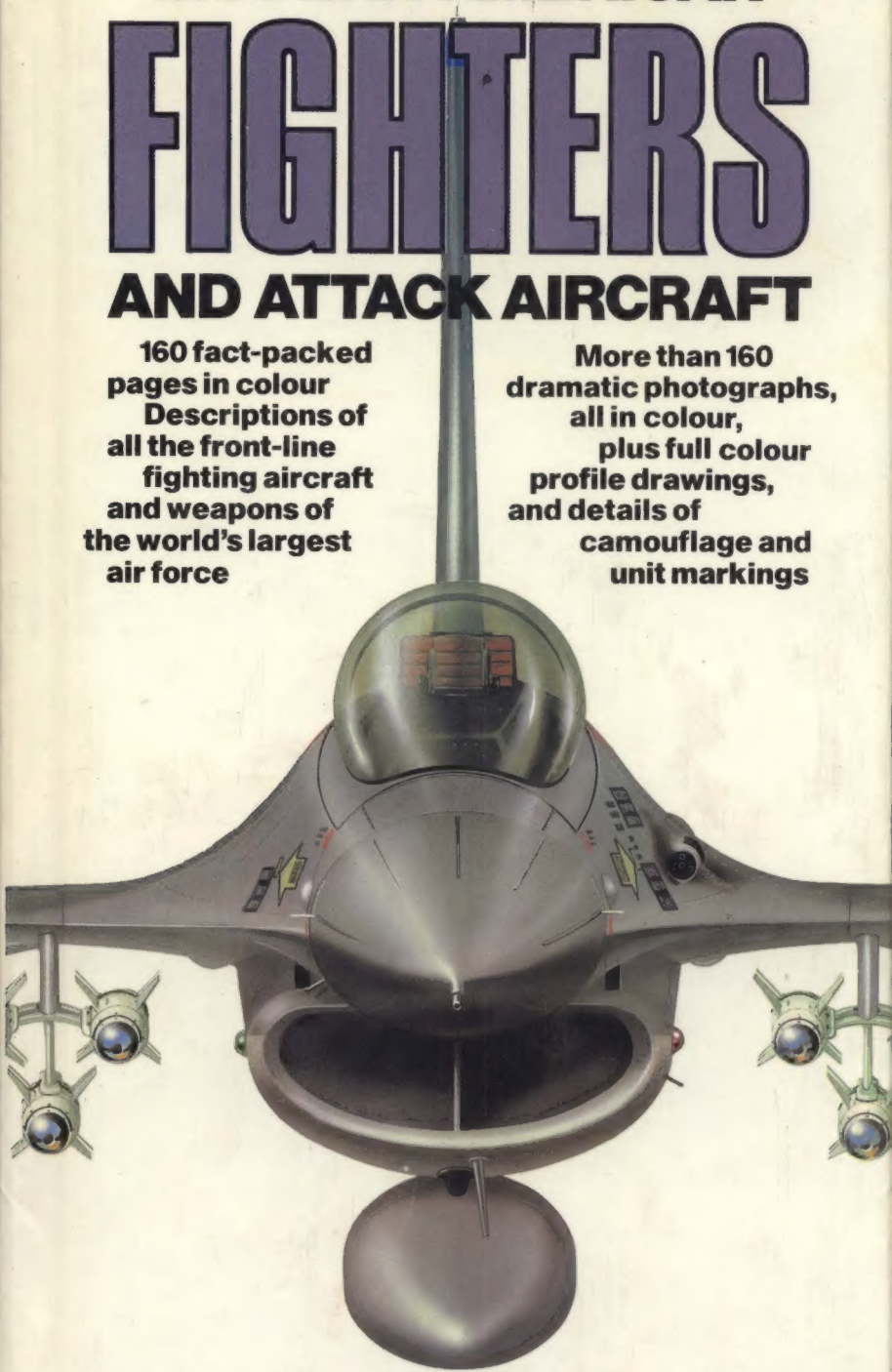
AN ILLUSTRATED GUIDE TO

MODERN AMERICAN FIGHTERS AND ATTACK AIRCRAFT

160 fact-packed pages in colour
Descriptions of all the front-line fighting aircraft and weapons of the world's largest air force

More than 160 dramatic photographs, all in colour, plus full colour profile drawings, and details of camouflage and unit markings



Barry C. Wheeler

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a Salamander book

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Introduction

ANY review of American fighter and attack aircraft is inextricably linked with the operating arms, and in the case of the USA this involves four major organisations — the US Air Force, the US Navy, the US Marine Corps and US Army Aviation. Together they operate more than 15,000 aircraft, the largest number of military aeroplanes and helicopters used by any single nation.

The US Air Force was established in 1947 from the US Army Air Force and is today the most powerful single military arm in the USA (and, indeed, in the western world). Although the USAF comprises some twelve different Commands, there are just two principal front-line formations — Strategic Air Command, with headquarters at Offut AFB, Nebraska, and Tactical Air Command, embracing Air Defence TAC (ADTAC), at Langley AFB, Virginia. In addition there are the TAC-assigned units in the Air National Guard and the Air Force Reserve. Outside the USA there are the US Air Forces in Europe, Pacific Air Forces and Alaskan Air Command.

While the user — SAC or TAC — is the final link in the evolutionary chain which produces American combat aircraft, there are other elements in between, one of the most important being Air Force Systems Command, which evaluates the aircraft or weapons required by the operator; a successful evaluation will result in AFSC placing a contract with the manufacturer.

Below: Still one of the world's most impressive warplanes more than thirty years after the prototype first flew, the B-52 Stratofortress remains SAC's "Big Stick" and is still considered a capable bomber. This is a B-52H, the last production version.

Above: One of the two B-1A prototypes which formed a vital element in the B-1B development programme, with "chase" F-111A. With 100 aircraft planned for service, the B-1B will be the backbone of SAC's long-range strike force in the 1990s, by which time the advanced cruise missile will form the aircraft's main armament.

Strategic Air Command

SAC controls two elements in the West's strategic deterrent: the ICBM force of 38 Titan IIs and 1,000 Minuteman II/IIIs; and a manned bomber force of 264 B-52G/Hs and 56 FB-111As, plus, from 1985, 100 B-1Bs. The Titans are due for final withdrawal in October 1987, and the new Peacekeeper (M-X) ICBM is planned for initial deployent at Warren AFB, Wyoming, in 1986.

The first Rockwell B-1B strategic bomber took off on its maiden flight on 18 October 1984, heralding the much-needed extension of SAC's man-

ned element in the US "triad" deterrent. The B-52 force, however, poses a problem for the Command. The majority of these eight-engined giants are now more than twenty years old, and it is generally felt that updating and modernising these aircraft can only go so far. Current plans indicate that some or all of the G series aircraft will be retired towards the end of the 1980s but that the turbofan-powered Hs will remain in use as cruise missile carriers into the 1990s (although in the event of war with the Soviet Union their operational role would increasingly emphasise stand-off missions in place of the penetration of Soviet airspace).

SAC still considers the present B-52 force to be a viable strike element, but the conventional attack role is clouded owing to the lack of effective munitions. "Iron" bombs tend to bounce off runways when delivered at low level, and so a number of alternative systems are being considered, including the development of a long-range (1,000lb class, 150nm) missile with a single warhead or submunitions, and a conventional version of the cruise missile. Supported by the airborne tanker fleet of KC-10s and KC-135s, the B-52s roam the western world, often armed and on constant alert. At any one time, 30 per cent of these bombers are ready for action

Above: Speeding along a valley, a bomb-carrying FB-111A from Mountain Home AFB, Idaho, conducts a typical practice low-level strike mission. On an active wartime sortie this aircraft would more likely carry four SRAMs under the wings to give a degree of stand-off capability from the target. Ordered as a replacement for the B-58 Hustler, the FB-111A retains the basic fuselage of the tactical versions but has bigger wings for more fuel. SAC plans to keep the fleet of fifty-plus aircraft in use for some time to come, maintaining their capability with regular system updates. Although originally much maligned, the FB-111A has confounded its critics and shown itself to be a fine machine.

parked on angled "Christmas tree" hardstandings at bases across the USA.

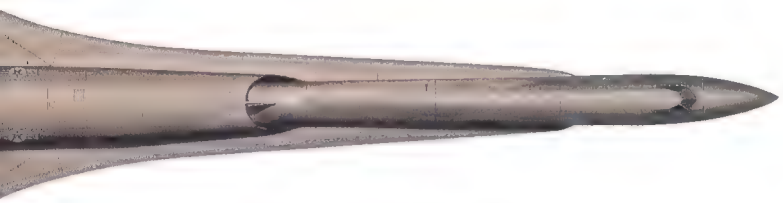
As well as the B-1B, SAC has the Advanced Technology Bomber (ATB) to look forward to in the 1990s. This "stealth" design is currently in the early planning stages, with Northrop being the main contractor. ATB is highly secret. Little is known about the design, except that the aircraft is likely to be a "flying wing" shape (Northrop has considerable experience in this field) making use of lightweight composite materials, buried engines and, with hardly a sharp corner to be seen, minimal radar reflectivity. Armament will include the advanced cruise missile now under development by General Dynamics and the planned replacement for SRAM.

Tactical Air Command

If you are on fighters, traditionally you are the "cream of the crop", the "Glamor Guys". Those in the other flying trades might vehemently disagree, but whichever way you look at it, the fighter aircraft is at the forefront of flying technology and the US Air Force is acknowledged to operate some of the most advanced combat aircraft in the world. Basic TAC statistics show nearly 2,400 aircraft looked after and supported by more than 114,000 personnel, with an additional 1,500 aircraft assigned to TAC in the Air National Guard and Air Force Reserve.

The present TAC line-up consists of some 36 wings of F-4s, F-15s, F-16s, F-111s, A-7s and A-10s, although the Command is planning to increase this to 40 wings by 1989. Whether this will be achieved depends on the levels of procurement over the next few years, but at least 270 new aircraft will have to be bought annually to attain the force increase and at the same time replace accident losses. The worry for TAC planners is the steady ageing of the aircraft on the inventory. It is eleven years since the F-15 Eagle entered service and more than twenty years since the mighty F-4 Phantom arrived, and the latter type remains the most numerous combat jet in TAC. It is no secret that the F-15 is expensive or that TAC would like more of them, but the Command has to spread its allocated budget across the whole spectrum of its operations and no more money has been forthcoming from Congress for additional dedicated interceptor Eagles.

A partial answer is the F-15E dual-role fighter, which is intended to replace the F-4 from 1988. A two-seat aircraft developed from the training Eagle, the E will give TAC an extra 392 fighters for twelve squadrons and two training squadrons which will double as all-weather deep-interdiction strike aircraft.



Above and below: Is this what the USAF's Advanced Tactical Bomber will look like? Probably not, but ATB designers at Northrop are unlikely to deny or confirm this futuristic shape which is just one artist's idea of a "stealth" aircraft.

Above: The F-15E, dubbed "Strike Eagle", is shown here armed with four Sidewinder AAMs and five Mk 83 1,000lb (450kg) bombs.

Right: A two-seat F-15B Eagle afterburns its way skyward with the gear doors almost closed and take-off flap position set.

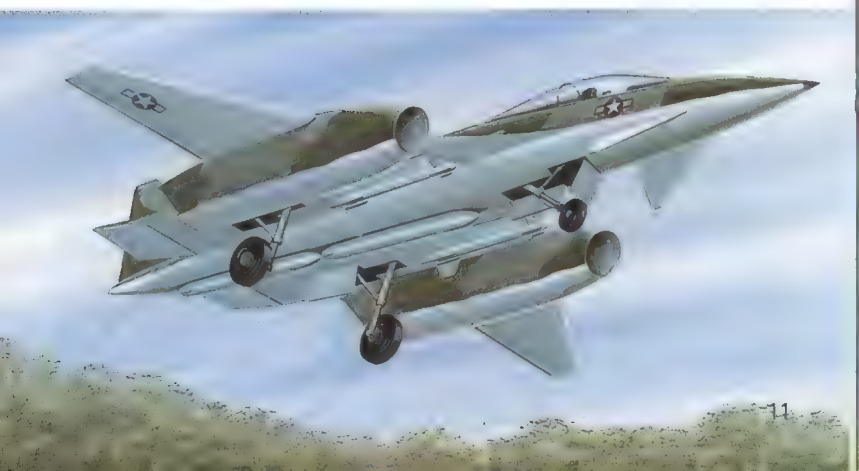
Right below: A stillborn McDonnell Douglas project dating from 1977 which incorporated canards and vectoring rear engine nozzles for STOVL operation. The ATF will be advanced in performance but conventional in design to reduce teething problems.

Companion to the F-15 is the small F-16, a real "hot rod" among fighters which is liked by its pilots and has gained considerable success in the export market. Known as a "swing" aircraft because of its air-to-air and air-to-ground roles, the F-16 tackles the good-weather interceptor mission in the USA, and also in Europe with USAFE and in South Korea with PACAF. It is a match for any current Soviet fighter, but it lacks range and payload for the interdiction role and its airframe is not sufficiently roomy for the bigger and better avionics necessary for the all-weather role. A solution, however, is a podded system called LANTIRN (Low-Altitude Navigation and Targeting Infrared for Night), which will give aircraft such as the F-16, A-10 and F-15E the ability to attack targets by day or by night in all but the very worst weather. The Air Force plans to buy 720 sets of pods.

The comparative cheapness of

the F-16 has encouraged the USAF to continue its procurement of the aircraft, and General Dynamics are hopeful that they can tempt the Air Force to buy the advanced delta-winged F-16F, developed from the F-16XL, which failed in the USAF's dual-role fighter competition. The F would have a larger engine, with a consequent increase in performance. It has also been admitted by the service that the two-seat F-16D would make an ideal reconnaissance platform to replace the thirteen squadrons of RF-4C photo-Phantoms.

Force enhancement for TAC over the next five years includes the introduction of AMRAAM for the fighters and of a self-defence capability for the A-10, A-7 and F-111 (by fitting them with all-aspect AIM-9L Sidewinders), and the Advanced Tactical Fighter (ATF). Like the ATB, the ATF is in the early stages of development, and service entry date is expected to be in the early 1990s. It is intended that the ATF should be able to fight and defeat the best of the future Soviet combat aircraft and include features such as supersonic cruise, high manoeuvrability and long range. Current thinking within TAC is that the ATF should not be totally "high-tec", with all the inherent problems that would pose for service integration, but that it should have an advanced fuel-efficient engine, partial composite structure and better short-field performance than present fighters. Despite the operational success that British Harriers and Sea Harriers achieved during the Falklands War, the USAF remains unconvinced that dispersed V/STOL aircraft would have a



better chance of surviving in a major conflict than fixed-base aircraft. ATF will therefore remain a firm "concrete hugger", and the wisdom of this would only be proved in a future conflict.

The Navy Scene

Just as the Commands make up an integral part of the USAF fighter scene, so the aircraft carrier is the Navy's lynch-pin. At present there are thirteen attack carriers in service, and the Navy plans to build up this number to fifteen by 1990 (see table). The carrier fleet is divided into two, Atlantic and Pacific, the aviation units based aboard ship coming under the control of either the Commander of the Naval Air Force Atlantic Fleet (COMNAVAIRLANT) or the Commander Naval Air Force Pacific Fleet (COMNAVAIRPAC). As well as an aircraft complement of some ninety machines, forming a Carrier Air Wing (CVW), each of the larger carriers accommodates some 6,000 men, half of whom are attached to the CVW and the remainder forming the ship's company.

Like the USAF, the Navy is embarking on a re-equipment programme for its combat units. Legendary aircraft like the A-4 Skyhawk and F-8 Crusader are no longer regularly deployed at sea, and the F-4 Phantom is rapidly coming towards the end of its sea-going life. In their place comes the F/A-18 Hornet which, as its designation implies, is a dual-role aircraft. Criticised and condemned by its opponents, the Hornet is steadily brightening its tarnished image as a poor performer and is now joining Navy and Marine Corps squadrons, some afloat, and receiving much praise from pilots and ground crew alike, who are determined to make the aircraft work. As well as replacing the F-4 in the fighter role, the Hornet is taking the place of the A-4 Skyhawk and the A-7 Corsair II in the attack role, its predecessors moving to the Reserve squadrons. In fact, the long-term plan for the second-line units is to modernise them with new Hornets at the same time as the active units: this is intended to provide a more effective force and give the Reserve units the capability of deploying to the carriers for operation alongside front-line squadrons flying the same aircraft. The Navy is looking

US Carriers and their Air Wings

Ship	Hull no.	Fleet	Home port	Wing
Midway	CV41	Pacific	Yokosuka	CVW-5
Coral Sea	CV43	Atlantic	Norfolk	CVW-13
Forrestal	CV59	Atlantic	Norfolk	–
Saratoga	CV60	Atlantic	Mayport	CVW-17
Ranger	CV61	Pacific	San Diego	CVW-9
Independence	CV62	Atlantic	Norfolk	CVW-6
Kitty Hawk	CV63	Pacific	San Diego	CVW-2
Constellation	CV64	Pacific	North Island	CVW-14
Enterprise	CVN65	Pacific	Alameda	CVW-11
America	CV66	Atlantic	Norfolk	CVW-1
John F Kennedy	CV67	Atlantic	Norfolk	CVW-3
Nimitz	CVN68	Atlantic	Norfolk	CVW-8
Dwight D Eisenhower	CVN69	Atlantic	Norfolk	CVW-7
Carl Vinson	CVN70	Pacific	Alameda	CVW-15
Theodore Roosevelt	CVN71	–	–	–
Abraham Lincoln	CVN72	–	–	–
George Washington	CVN73	–	–	–

Above: A Pacific Fleet F-14A Tomcat, with wheels, hook and flaps down for landing, approaches the deck of USS *Constellation*.

towards forming the 15th CVW from the Naval Air Reserve over the next five years or so.

On the horizon is the long-awaited Tomcat upgrade programme, which will give the carrier fighter squadrons the more capable F-14D. This version will have more powerful General Electric F110 engines, a digital weapons aiming system, Improved Phoenix and the AMRAAM missile. Not including the Midways, each carrier will eventually have two 12-plane squadrons of Tomcats for fleet defence; *Midway* and *Coral Sea* do not have the capability to operate this type of aircraft and Hornets are taking the place of Tomcats on these ships. The reconnaissance stop-gap of the

Below: A busy flight-deck scene pictured during carrier trials with the F-18 Hornet (centre); on the right and behind are two aircraft it is replacing, the A-7 Corsair and the RF-4B Phantom.

TARPS-equipped F-14 will be resolved by purchasing the RF-18 for the Navy and Marines.

The other Navy programme which falls within the scope of this book is the A-6E Intruder upgrade: better avionics and increased performance will help see this all-weather attack aircraft into the 1990s. The decision to keep the Intruder instead of ordering the development of a brand-new design has been dictated principally by a lack of funds and by the relatively short development period necessary for a modernised A-6 compared to that for a new aircraft.

The Navy and the Air Force are keen to develop closer ties, and to this end the USAF is now flying ocean surveillance missions with B-52s. Armed with Harpoon air-to-surface missiles, mines and sonobuoys, these aircraft have been found to be ideal long-range reconnaissance platforms, able to remain airborne for many hours over large tracts of the Atlantic, Pacific and Indian Oceans, supplementing the P-3 Orion patrol aircraft and co-operating closely with the carrier battle groups.

The Flying Leathernecks

The US Marine Corps retains this affectionate nickname, but its Second World War connotation is far removed from the situation in which the Corps now finds itself. Today, the USMC aviation element is divided into three Marine Aircraft Wings (MAW) tasked with supporting Marine ground forces: the 1st MAW,

Above: The first F-18 Hornet of the second production batch on test prior to handing over to the USMC. Carrier-deployed in 1984, the Hornet is gaining respect after heavy criticism.

Left: Safety warning horns blaring, a Marine AV-8B comes up to the flight deck for a test hop during final trials. The light grey drop tanks have yet to receive a coat of dark green/grey camouflage.

based at Iwakuni, Japan; the 2nd MAW, at Cherry Point, North Carolina; and the 3rd MAW, headquartered at El Toro, California. In addition, the 4th MAW at New Orleans, Louisiana, controls Marine reserve units.

One of the new roles of the USMC is to provide the core of the Rapid Deployment Joint Task Force which is aimed at protecting US interests in the Middle East, particularly around the Persian Gulf. With the aid of stores of pre-positioned equipment, the Corps also has a NATO remit to aid Allied forces in northern Norway in the event of war with the Soviet Union.

Like the Navy, the USMC is taking delivery of F/A-18 Hornets to replace its F-4 Phantoms, and the first squadrons are now operational; the Hornet will undertake the long-range fighter and attack roles, whilst the new AV-8B Harrier II will be the Corps' short-range "bomb-truck". The USMC has been unwavering in its faith in the vertical take-off Harrier, which can be stationed close to the combat zone, hide within trees and brush, just like a rifleman in a foxhole, and rise up suddenly to deliver a range of ordnance against an enemy. More than 300 Harrier IIs will replace the existing A-4s and AV-8A/Cs.

Army Aviation

Almost 9,000 machines equip the aviation element of the US Army; more than 8,000 of these are helicopters, making this service the world's largest operator of rotorcraft. Two main attack helicopters are operated by the US Army, the AH-1 Cobra and the advanced AH-64 Apache, although other types such as the UH-60 Blackhawk also have the ability to mount fire suppression guns and bolt-on anti-tank missiles. While the TOW missile-armed AH-1 has been in service since the late 1960s and has achieved a good degree of

Above: The standard US Army attack helicopter is the Bell HueyCobra. This AH-1S version has just fired a TOW anti-armour missile.

reliability in operation, the Apache is just starting its service career and has yet to prove itself. Of the 675 AH-64s the US Army says it needs, 267 had been funded up to 1985. This is an expensive programme for the Army, and the high technology built into the Apache underlines the "quality over quantity" argument in the US-Soviet scenario. Without doubt, the Apache's all-weather capability will greatly enhance NATO's defensive stance, and if everything works as it should the Apache will be a most impressive tank-killer. Its Achilles' heel is that it does not have the mast-mounted sight which is current "state of the art" in attack helicopters. An Apache crew could find itself feeling very naked when having to rise up to expose the nose-mounted sighting system before loosing off gunfire or missiles. However, the joint attack form of operation involving USAF A-10s and Army AH-1s/AH-64s on the Central Front battlefield should reduce this feeling of isolation and increase the undoubted confusion which is likely to exist in such a conflict.

For the future, the Army is looking towards the LHX (Light Helicopter Experimental) to fulfil its requirement for an AH-1 replacement, envisaging the acquisition of 1,103 of the SCAT

Below: Down among the scrub is where the Hughes AH-64 Apache likes to be to avoid detection when hunting tanks.

(Scout-Attack) version. Service entry date is planned for 1992. Broad design parameters include a gross weight about half that of the Apache, a high dash speed, single pilot operation and an endurance of up to three hours. A number of US companies are working on advanced helicopter designs, and it will be interesting to see just how close the eventual LHX winner will come to meeting the full Army specification.

Combat Colours

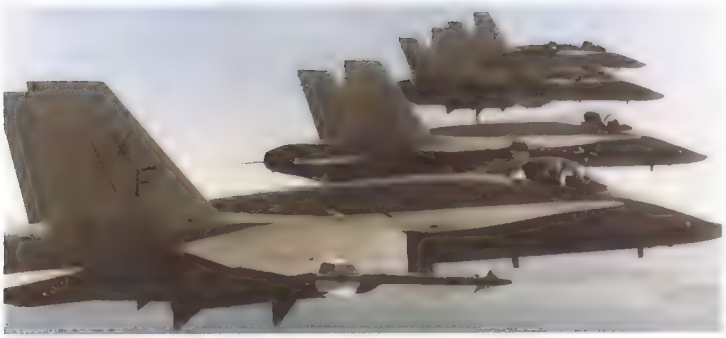
Covering an aircraft with paint can noticeably increase its weight, especially in the case of a machine the size of a B-52 or B-1, and consequently much thought and experimentation goes into the art of camouflage. The trend in recent years has been to reduce bright colours on American service aircraft (and, for that matter, on all NATO-operated aircraft) to a minimum, and gaudy stripes, squadron and/or Wing badges and even some of the larger maintenance stencilling have all but disappeared from USAF tactical aircraft. Apart from the need to conceal or reduce the shape of an aircraft from the eyes of an enemy, the cost and man-hours involved in applying the markings are the main reasons for the tone-down. On the A-10, for example, the number of stencil markings has been cut from 681 to 95.

The present camouflage on USAF aircraft has its origins in the Vietnam War, but the end of that conflict and America's large-scale redeployment of aircraft to Europe necessitated a rethink. Following a number of trials, "European 1" emerged as the new camouflage and was officially adopted for the A-10 Thunderbolt. Applied on all surfaces, the scheme comprises greens 34092 and 34102, and grey 36081. A similar pattern was chosen for other aircraft such as the C-5A, C-141 and C-23 but differs in having grey 36118 in place of the darker 36081.

While European 1 is intended for concealment at low level and at airfield dispersals, USAF interceptors have retained grey colours for the high-altitude role. Types such as the F-15 and F-16 employ two shades of grey for upper surfaces and a lighter grey underneath. National markings

Below: The US interceptor force has adopted grey as the predominant colour, and the two shades are clearly seen on this F-16.

Above: The European 1 camouflage scheme was originally devised for the A-10A Thunderbolt to conceal it during low-level flight. Recent Tech Orders decree that the bright TAC badge on the fins of these aircraft be toned down to a single black outline design.



Above: Hornets of the US Navy's Test and Development Squadron VX-4 at Point Mugu. They carry a grey scheme for both the high-altitude fighter role and the low-level over-water attack mission. For the present, the colourful markings of past years have gone.

are applied small, in black or grey outline, whilst tail codes are usually painted larger although still in dark colours.

Bright colours have their place, notably on the F-5E "Aggressor" aircraft where various greys, blues, browns and greens are carried, apparently to simulate combat schemes favoured by various operators of Soviet aircraft. Air defence F-106s and their F-15 successors still retain large, colourful tail insignia, but these are almost the exception in the US services.

Navy and Marine Corps aircraft have also lost their bright plumage of late. In place of the flamboyant squadron insignia covering the fins and rudders of such aircraft as the F-14, A-6 and A-7, only grey or black outline markings are now sported, over low-visibility medium grey camouflage. On the tactical front, Marine Harriers, OV-10s and Cobra helicopters have yet

Left: Large tail codes and small "star and bar" national insignia are the only prominent markings visible on this Alaskan-based F-15.

Below: When the USMC first received its AV-8A Harriers the aircraft were painted in UK green/grey camouflage, with conventional insignia.

Left: With wings at half-sweep, an F-111D releases twelve Mk 82 bombs during an exercise. A mission at such a height would be unlikely against defences of the calibre of those deployed by the Soviet Union; hi-lo-hi would be more typical. The aircraft has Vietnam-style camouflage.

Right: East meets west over the Land of the Pharaohs. Exercises involving the USAF and the Arab Republic of Egypt Air Force provide opportunities for off-beat formations: here an A-10A Thunderbolt in European 1 colours contrasts with the grey F-16 in the centre flanked by a two-seat MiG-15UTI and a MiG-21FL. Such US/Egyptian exercises carry the name "Bright Star".

to catch the seemingly endless spread of grey paint, these machines having a dark green/dark grey upper surface camouflage to comply with their low-level/dispersed-site style of operation. US Army helicopters have retained a dark olive drab overall scheme for their low-level role down among the trees. Official markings are few and those that are present have usually been applied in black.

The switch to all these dull colours and the almost total absence of colourful squadron badges and insignia represent a disturbing reflection on the current state of the tension between East and West; a lessening of that tension could mean the return of the bright, attractive colours of the 1960s.

Flag Exercises

First established in 1975, the Flag exercises held by the United States Air Force have become some of the best-known training tests in the world. Organised under the auspices of Tactical Air Command, they are designed to prepare personnel for the extremes of combat through training that is as realistic as possible in peacetime. As well as US military aircraft, these exercises involve detachments of Royal Air Force, Canadian, Dutch and French Air Force aircraft. The US Navy conducts similar combat exercises, known as "Top Gun", based at NAS Miramar, California.

This form of training was prompted by the increasing threat posed by the Soviet armed

Below: The strangely marked F-5E Aggressor aircraft have become synonymous with the famous Red Flag exercises at Nellis AFB.

Above: F-111s prepare to do battle with Aggressor F-5Es. Cockpits remain open to reduce temperatures in the baking desert heat.

forces and in the light of the lack of combat experience suffered by most US/NATO personnel. Realism is the byword of Flag operations, and pilots posted to the training units receive detailed briefings on Soviet tactics and doctrine; their aircraft, generally Northrop F-5Es, carry the camouflage schemes applied to Soviet MiGs. The principle Flag exercises are:

Red Flag Air combat exercises for aircrew usually held at Nellis AFB, Nevada, involving mock combat against Aggressor aircraft (mainly F-5Es playing the part of MiGs) armed with drill missiles and simulating Soviet fighter tactics. Additionally, simulated SAMs (known as "Smokey Joes" because of their realism when fired) and AA guns are employed. Seven Red Flag exercises are held each year.

Copper Flag Air defence exercises usually held three times a year, designed to test TAC air and ground crews, centred at Tyndall AFB, Florida, and simulating high-threat situations involving nuclear weapons attacks on North America. Both SAC and the Air Defence TAC take part, the defending aircraft comprising F-15s and F-106s.

Chequered Flag Intended to train TAC crews in overseas deployment and to ensure that on arrival at their designated wartime bases they will be ready to begin combat air operations.

Green Flag Training in electronic warfare under the control of the Tactical Air Warfare Centre at Eglin AFB, Florida, with a flying exercise at Nellis AFB to test and assess the effect of ECM on combat operations.

Blue Flag Quarterly exercises aimed at developing battle management skills and operated by the TAWC, Eglin AFB. The programme is geared to specific areas of the world which are seen as present or future "trouble spots", for example Europe, Korea and the Middle East. The courses are also attended by officers from "friendly" nations.

Black Flag A series of exercises to test the maintenance and supply organisation under simulated combat conditions. It includes high sortie rates from remote locations combined with the necessary supply functions to support dispersed units.

Silver Flag Exercises to determine the number of key personnel required in certain critical areas in wartime conditions. Those identified are given regular training and usually participate in Red Flag.

Gold Flag Readiness training programmes designed to increase aircraft utilisation rates through monthly flying targets set by TAC HQ at Langley AFB.

Other exercises are held at most bases to test squadron efficiency and maintain the highest possible standards.

Tail Codes

The present style of tail codes was first applied to USAF Tactical Air Command aircraft during the Vietnam War in 1967, and for reporting purposes provided an indication of an aircraft's unit and main operating base. The current code usually takes the form of a two-letter abbreviation of the airfield name, but this is by no means guaranteed, as the accompanying tables show.

During the late 1960s and 1970s, the 24in (610mm) high letters were officially applied in lustreless light grey paint, but they often appeared in white because of individual maintenance units' interpretations of the Technical Orders. These light colours showed up prominently against the drab camouflage on the aircraft's fins, but in recent years, in accordance with orders to tone down colours which compromised tactical camouflage, tail codes on USAF aircraft have been applied in black (which makes identification easy on a grey painted F-16 but much more difficult on a dark green Phantom).

Fin code positioning is not as haphazard as might initially be thought. The two letters are ap-

USAF Tail Codes

Code	Unit	Aircraft	Base
AD	3246 TW	A-10, F-4, F-15, F-16, F-111, RF-4	Eglin
AK	21 TFW/ 343 CW	A-10, F-15	Eielson/Elmendorf
AL	160 TFS	F-4D	Donnelly Field
AR	10 TRW	RF-4C	Alconbury (UK)
AZ	162 TFG	A-7	Tucson
BA	67 TRW	RF-4C	Bergstrom
BC	110 TASG	OA-37	Battle Creek
BD	917 TFG	A-10	Barksdale
BT	36 TFW	F-15	Bitburg (FRG)
CC	27 TFW	F-111	Cannon
CO	140 TFW	A-7	Buckley
CR	17 AF	F-15	Soesterberg (Neth)
CT	103 TFG	A-10	Bradley
DC	113 TFW	F-4	Andrews
DM	355 TTW	A-10	Davis-Monthan
DO	906 TFG	F-4	Wright-Patterson
ED	AFFTC	A-7, A-10, F-4, F-15, F-16, F-111	Edwards
EG	33 TFW	F-15	Eglin
EL	23 TFW	A-10	England
FF	1 TFW	F-15	Langley
FL	549 TACG	?	Patrick
FM	482 TFW	F-4	Homestead
FW	122 TFW	F-4	Baer Field
GA	35 TFW	F-4	George
HA	185 TFG	A-7	Sioux City
HF	181 TFG	F-4	Hulman Field
HI	419 TFW	F-16	Hill
HL	388 TFW	F-16	Hill
HO	49 TFW	F-15	Holloman
HR	50 TFW	F-16	Hahn (FRG)
IA	132 TFW	A-7	Des Moines
IL	182 TASG	OA-37	Peoria
IN	434 TFW	A-10	Grissom
KC	442 TFW	A-10	Richards Gebaur
KE	186 TRG	RF-4C	Key Field
KY	123 TRW	RF-4C	Standiford Field
LA	405 TTW	F-15	Luke
LF	58 TFW	F-16	Luke
LN	48 TFW	F-111	Lakenheath (UK)
LV	4450 TG	A-7	Nellis
MA	104 TFG	A-10	Barnes
MB	354 TFW	A-10	Myrtle Beach
MC	56 TTW	F-16	MacDill
MD	175 TFG	A-10	Glenn Martin
MI	127 TFW	A-7	Selfridge
MO	366 TFW	F-111, EF-111	Mountain Home
MY	347 TFW	F-4	Moody
NA	474 TFW	F-16	Nellis
NF	602 TACW	OA-37	Davis-Monthan
NJ	108 TFW	F-4	McGuire
NO	442 TFW	A-10	New Orleans
NY	174 TFW	A-10	Hancock Field
OH	121 TFW	A-7	Rickenbacker
OK	138 TFG	A-7	Tulsa
OS	51 TFW	OA-37, F-4	Osan/Taegu (SK)
OT	TAWC	A-10, RF-4C, F-15, F-16	Eglin
PA	111 TASG	OA-37	Willow Grove
PN	3 TFW	F-4	Clark (Phil)
PR	156 TFG	A-7	Muniz
PT	112 TFG	A-7	Greater Pittsburgh
RG	AFLC	F-15	Robins
RS	86 TFW	F-4	Ramstein (FRG)
SA	149 TFG	F-16	Kelly
SC	169 TFG	F-16	McEntire
SD	114 TFG	A-7	Sioux Falls
SH	507 TFG	F-4	Tinker
SJ	4 TFW	F-4	Seymour-Johnson
SL	131 TFW	F-4	Lambert St Louis
SP	52 TFW	F-4	Spangdahlem (FRG)
SU	25 TFS	A-10	Suwon (SK)
SW	363 TFW	RF-4C, F-16	Shaw
TH	301 TFW	F-4	Carswell
TJ	401 TFW	F-16	Torrejon (Sp)
TX	924 TFG	F-4	Bergstrom
TY	325 TTW	F-15	Tyndall
UH	20 TFW	F-111, EF-111	Upper Heyford (UK)
VT	158 TFG	F-4	Burlington
WA	57 FWW	A-10, F-4, F-15, F-16, F-111	Nellis/McClellan
WH	22 TASS	OV-10	Wheeler
WI	128 TFW	A-10	Traux Field
WP	8 TFW	F-16	Kunsan (SK)
WR	81 TFW	A-10	Woodbridge (UK)
WW	37 TFW	F-4	George
ZF	31 TTW	F-4, F-16	Homestead
ZR	26 TRW	RF-4C	Zweibrucken (FRG)
ZZ	18 TFW	RF-4C, F-15	Kadena (Ok)

FRG - Federal Republic of Germany; Neth - Netherlands; Ok - Okinawa; Phil - Philippines; SK - South Korea; Sp - Spain; UK - United Kingdom.

USN Tail Codes

Code	Unit	Aircraft	Carrier/Base
AA	VF-74	F-14A	**Saratoga**
	VF-103	F-14A	
	VA-81	A-7E	
	VA-83	A-7E	
AB	VF-33	F-14A	**America**
	VF-102	F-14A	
	VA-34	A-6E	
	VA-46	A-7E	
	VA-72	A-7E	
AC	VF-11	F-14A	**John F Kennedy**
	VF-31	F-14A	
	VA-75	A-6E	
	VA-85	A-6E	
AD	VF-43	A-4E/F, F-5E, F-21	Oceana
	VF-101	F-14A	Oceana
	VA-45	TA-4J	Key West
	VA-42	A-6E	Oceana
	VA-174	A-7E	Cecil Field, Yuma
AE	VF-14	F-14A	**Independence**
	VF-32	F-14A	
	VA-15	A-7E	
	VA-87	A-7E	
	VA-176	A-6E	
AF	VF-201	F-4S	Dallas
	VF-202	F-4S	Dallas
	VA-203	A-7E	Cecil Field
	VA-204	A-7B	New Orleans
	VA-205	A-7B/E	Atlanta
AG	VF-142	F-14A	**Dwight D Eisenhower**
	VF-143	F-14A	
	VA-12	A-7E	
	VA-65	A-6E	
	VA-66	A-7E	
AJ	VF-41	F-14A	**Nimitz**
	VF-84	F-14A	
	VA-35	A-6E	
	VA-82	A-7E	
	VA-86	A-7E	
AK	VFA-131	F/A-18A	**Coral Sea**
	VFA-132	F/A-18A	
	VFA-136	F/A-18A	
	VFA-137	F/A-18A	
	VA-55	A-6E	
BA	Blue Angels	A-4F	Pensacola
ND	VF-301	F-4S	Miramar
	VF-302	F-4S	Miramar
	VA-303	A-7B	Alameda
	VA-304	A-7B	Alameda
	VA-305	A-7B	Point Mugu
NE	VF-1	F-14A	**Kitty Hawk**
	VF-2	F-14A	
	VA-145	A-6E	
	VA-146	A-7E	
	VA-147	A-7E	
NF	VF-151	F-4S	**Midway**
	VF-161	F-4S	
	VA-56	A-7E	
	VA-93	A-7E	
	VA-115	A-6E	
NG	VF-24	F-14A	**Ranger**
	VF-211	F-14A	
	VA-165	A-6E	
	VA-192	A-7E	
	VA-195	A-7E	
NH	VF-114	F-14A	**Enterprise**
	VF-213	F-14A	
	VA-22	A-7E	
	VA-94	A-7E	
	VA-95	A-6E	
NJ	VF-121	F-4J	Miramar
	VF-124	F-14A	Miramar
	VF-126	A-4F, TA-4J	Miramar
	VA-127	TA-4J	Lemoore
	VA-128	A-6E	Whidbey Island
	VA-122	A-7E, TA-7C	Lemoore
NK	VF-21	F-14A	**Constellation**
	VF-154	F-14A	
	VFA-25	F/A-18	
	VFA-113	F/A-18	
	VA-196	A-6E	
NL	VF-51	F-14A	**Carl Vinson**
	VF-111	F-14A	
	VA-27	A-7E	
	VA-52	A-6E	
	VA-105	A-7E	
NM	VFA-125	F/A-18	Lemoore
UA	VC-1	A-4E	Barbers Point
UE	VC-5	A-4E	Cubi Point
UH	VC-7	A-4F	Miramar
XE	VX-5	A-4F/M A-6E, A-7E, OA-4M	China Lake
XF	VX-4	F-14A, F-4S, F/A-18	Point Mugu

plied in relation to airframe panels or other features, and their position varies from one aircraft type to another, depending on tail shape, aerials, other markings, etc.

US Navy tail codes differ from those used by the USAF in that they signify the Carrier Air Wing (CVW) to which the aircraft is attached, and by implication the squadron. Although there are variations, the average CVW is composed of two fighter squadrons (VF), with 24 F-14A Tomcats; two light attack squadrons (VA), with 24 A-7E Corsair IIs; one medium attack squadron (VA), with 10 or 11 A-6E Intruders; one tactical EW squadron (VAQ), with four EA-6B Prowlers; one AEW squadron (VAW), with four E-2C Hawkeyes; one ASW squadron (VS), with ten S-3A Vikings; and one helicopter ASW squadron (HS), with six SH-3H Sea Kings.

There are currently thirteen Air Wings in service, one for each of the operational attack carriers; a fourteenth CVW is scheduled to be activated in 1988 when *Theo-*

USMC Tail Codes

Code	Unit	Aircraft	Base
CF	VMA-211	A-4M	El Toro
CG	VMA-231	AV-8A	Cherry Point
CR	VMA-542	AV-8A	Cherry Point
DA	H&MS-32	OA-4M	Cherry Point
DB	VMFA-235	F-4S	Kaneohe Bay
DC	VMFA-122	F-4S	Beaufort
DN	VMFA-333	F-4S	Beaufort
DR	VMFA-312	F-4S	Beaufort
DT	VMA(AW)-242	A-6E	El Toro
DW	VMFA-251	F-4S	Beaufort
EA	VMA(AW)-332	A-6E	Cherry Point
EC	VMFA-531	F-18	El Toro
ED	VMA(AW)-533	A-6E	Cherry Point
ER	VMO-1	OV-10D	New River/Fulenma
HF	HMA-269	AH-1J/T	New River/Fulenma
KC	VMAT(AW)-202	A-6E	Cherry Point
KD	VMAT-203	AV-8A	Cherry Point
MA	VMFA-112	F-4S	Dallas
MB	VMA-142	A-4F	Cecil Field
ME	VMA-133	A-4F	Alameda
MF	VMA-134/ VMF-134	A-4F, F-4S	El Toro
MG	VMFA-321	F-4N	Andrews
MP	HMA-773	AH-1J	Atlanta
MU	VMO-4	OV-10A	Atlanta
QG	VMA-131	A-4E	Willow Grove
QP	VMA-124	A-4E	Memphis
QR	VMA-322	A-4M	South Weymouth
RF	VMFP-3	RF-4B	El Toro
SC	VMAT-102	A-4M, TA-4F	Yuma
SH	VMFAT-101	F-4J/S	Yuma
SM	HMA-369	AH-1J	Camp Pendleton
SN	HMA-169	AH-1T	Camp Pendleton
TQ	HMT-303	AH-1J	Camp Pendleton
UU	VMO-2	OV-10D	Camp Pendleton
VE	VMFA-115	F-4S	Beaufort
VK	VMA(AW)-101	A-6E	El Toro
VL	VMA-331	A-4M	Cherry Point
VM	VMFA-451	F-4S	Beaufort
VW	VMFA-314	F-18	El Toro
WA	H&MS-12	OA-4M	Iwakuni
WD	VMFA-212	F-4S	Kaneohe Bay
WE	VMA-214	A-4M	Iwakuni
WF	VMA-513	AV-8A	Yuma
WK	VMA(AW)-242	A-6E	Cherry Point
WL	VMA-311	A-4M	El Toro
WP	VMA-223	A-4M	El Toro
WS	VMFA-323	F-18	El Toro
WT	VMFA-232	F-4S	Kaneohe Bay
YU	H&MS-13	OA-4M	El Toro

dore Roosevelt is commissioned. A more immediate change is underway with the arrival of the F/A-18 Hornet whereby most of the carriers will receive two strike-fighter squadrons (VFA) in place of the single-mission A-7E units.

The carriers and their CVWs are divided into two Fleets, Atlantic and Pacific; the former have squadrons carrying codes prefixed with the letter "A", while the Pacific units have "N" prefixes. The accompanying list reflects the two Fleets and their supporting shore-based Reserve squadrons at the end of 1984. However, it is important to remember that individual squadrons can be switched between Air Wings and that Wings may be disbanded or reallocated to another carrier or Fleet, depending on the continuing Service Life Extension Program (SLEP) which US carriers undergo.

The accompanying lists are as complete as possible, but it should be borne in mind that units can change bases and even equipment at short notice.

Below: The code "HR" indicates that this F-4 belonged to the 50th TFW at Hahn AFB, West Germany; F-16s now equip the unit.

Bell AH-1 HueyCobra/ SeaCobra/SuperCobra

AH-1G, Q, S, T, T+

Origin: Bell Helicopter Textron, Fort Worth.
Type: Close-support and attack helicopter.
Engine: (AH-1J) One 1,800shp P&W Canada T400 Twin Pac with transmission flat-rated at 1,100shp; (S) 1,800shp T53–703; (T) 2,050shp T400-WV-402.
Dimensions: Diameter of two-blade main rotor 44ft (13·41m), (T) 48ft (14·63m); overall length (rotors turning) (S) 52ft 11½in (16·14m), (J) 53ft 4in (16·26m), (T) 58ft (17·68m); length of fuselage/fin 44ft 7in (13·59m), (T) 48ft 2in (14·68m); height 13ft 6¼in (4·12m).
Weights: Empty (J) 7,261lb (3,294kg), (S) 6,479lb (2,939kg), (T) 8,608lb (3,904kg); max (J, S) 10,000lb (4,535kg), (T) 14,000lb (6,350kg).
Performance: Max speed (J) 207mph (333km/h), (S with TOW) 141mph (227km/h); max rate of climb varies from (J) 1,090ft (332m)/min to (S) 1,620ft (494m)/min; range with max fuel typically 357 miles (574km).
Armament: Typically one 7·62mm multi-barrel Minigun, one 40mm grenade launcher, both in remote-control turret, or 20mm six-barrel or 30mm three-barrel cannon; four stores pylons for 76 rockets of 2·75in calibre or Minigun pods or 20mm gun pod, or eight TOW missiles in tandem tube launchers on two outer pylons; two AIM-9L Sidewinder AAMs on T+ SuperCobra.
History: First flight 7 September 1965, (T) 20 May 1976, (T+) 16 November 1983; combat service June 1967.
Users: US Army, USMC.

Development: Considered to be a revolutionary design when it first appeared in the late 1960s, the AH-1 HueyCobra was developed by Bell as a private venture and established the standard of layout for a generation of anti-tank helicopters. Using the basic rotor, engine and transmission system of the UH-1 utility transport, the AH-1 incorporated a streamlined, thin-profile fuselage with a gunner seated in the nose in front of the raised pilot position and an armament consisting of a chin-mounted gun supplemented by weapons pylons under the stub wings. This basic arrangement has been followed by similar designs currently being developed in Italy (Agusta A129), Germany (PAH-2 proposals) and even the Soviet Union (Mil Mi-28 Havoc, although this is more akin to the AH-64 Apache).

The AH-1G was the first production version of the Cobra for the US Army; 1,116 were built, the type accumulating more than one million flight hours in South-East Asia. In 1972 the first missile-armed Cobra, the AH-1Q fitted with the tube-launched TOW, was tested. A total of 92 were built, but performance was somewhat limited when the helicopter operated with a full load of eight rounds. This problem was resolved by increasing the engine power and uprating

Above: Identified by its flat cockpit panels, a Modernised AH-1S version hovers, armed with a 19-round rocket pod and its chin-mounted 20mm gun. The US Army wants 1,000 of these helicopters.

Left: Vietnam, where "Canned Heat" flew, became the proving ground for the armed helicopter.

Below: An early AH-1Q fires a TOW anti-armour missile during proving trials in 1973.

the transmission to produce the AH-1S, and all the Qs and 200 Gs were converted to S standard beginning in 1977. In addition to the conversions, 100 new AH-1Ss were produced to meet an Army shortfall in anti-tank helicopters, followed by a further batch of 98 which were known as Step 2 machines.

The Modernised AH-1S or Step 3 variant has more enhancements to improve the type's battlefield performance, not least in its capacity to operate ▶

throughout its full flight spectrum with eight TOWs. Its equipment fit includes a laser rangefinder, a Doppler navigation set, an engine heat suppressor to reduce IR signature, an IR jammer, and RWR linked with an AN/ALQ-136 jamming system. A low-glint, flat glass canopy replaces the original rounded type, and the rotor blades are made of lightweight composite materials.

As well as TOW, the Cobra can carry a range of rocket and gun pods and has successfully demonstrated the "fire-and-forget" Hellfire missile. The chin turret contains an M197 20mm three-barrel cannon with 750 rounds. To aim the weapons, the crew have helmet-mounted sights.

US Army units in Europe operate several hundred AH-1Ss and present plans call for the acquisition of 982 machines, 324 of which will be new-build aircraft and the rest converted Gs. Finished in dark low-IR-reflective paint, the European-based AH-1Ss are somewhat handicapped by the poor Continental weather, which impedes the use of the TOW missile as this is primarily a clear daylight weapon. To rectify this, the Army are hoping to equip the Cobra fleet with FLIR pods from about 1987, and the improved TOW 2 will also be supplied to units as production gets underway.

In the mid-1960s the US Marine Corps also saw a requirement for an attack helicopter and ordered 38 AH-1Gs, the first of which was delivered in February 1969; a further 67 twin-engined AH-1J SeaCobras followed, and by 1982 the Corps had received 51 improved AH-1Ts, some equipped with TOW. Another 44 Ts are on order to expand the present force of three active and one reserve

Below: While the US Army looks towards JVX and other new designs, the USMC is keen to continue its association with the Cobra family. The AH-1T and -1T+ are considered ideal support helicopters, and six active units are planned to receive these machines.

Above: The Marines liked the Cobra but wanted two engines for over-water safety so Bell produced the AH-1J SeaCobra.

squadron to six and two units respectively. These squadrons will also absorb a second helicopter type, possibly a maritime variant of the AH-64 Apache.

The latest development in the Cobra series is the AH-1T+ SuperCobra. This has a 65 per cent increase in installed power compared with the existing T thanks to the installation of two GE T700–401 engines rated at 1,625shp each. The USMC perceives this new variant as an escort machine for troop-carrying helicopters and has placed orders for 22 examples with deliveries beginning in March 1986, possibly followed by a further 22 in FY86. In its escort role the T+ will carry two AIM-9L Sidewinder air-to-air missiles on its stub wings and will accommodate the airborne version of the Stinger. The Army has decided not to order the SuperCobra, preferring instead to opt for development of the advanced LHX (Light Helicopter Experimental), a project still being defined.

Boeing B-52 Stratofortress

B-52G, H

Origin: Boeing Airplane Company (from May 1961 The Boeing Company), Seattle, Washington.
Type: Heavy bomber and missile platform.
Engines: (B-52G) Eight 13,750lb (6,237kg) thrust P&WA J57-43W or -43WB turbojets, (H) eight 17,000lb (7,711kg) thrust P&WA TF33-1 or -3 turbofans.
Dimensions: Span 185ft (56·39m); length (G/H as built) 157ft 7in (48m), (G/H modified) 160ft 11in (49·05m); height (G/H) 40ft 8in (12·4m); wing area 4,000 sq ft (371·6m²).
Weights: Empty about 195,000lb (88,450kg); loaded (G) 505,000lb (229,000kg), (H) 505,000lb at take-off, inflight refuel to 566,000lb (256,738kg).
Performance: Max speed (true airspeed, clean) 595mph (957km/h); penetration speed at low altitude about 405mph (652km/h, Mach 0·53); service ceiling (G) 46,000ft (14,000m), (H) 47,000ft (14,300m); range (max fuel, no external bombs/missiles, optimum hi-alt cruise) (G) 8,406 miles (13,528km), (H) 10,130 miles (16,303km); take-off run (G) 10,000ft (3,050m), (H) 9,500ft (2,895m).
Armament: (G) Four 0·5in (12·7mm) guns in remote-control tail turret, ASG-15 system, eight nuclear bombs or up to 20 SRAM, ALCM or mix (eight on internal dispenser plus twelve on wing pylons); (H) single 20mm six-barrel gun in remote-control tail turret, ASG-21 system, plus plus bombload as G.
History: First flight 15 April 1952.
User: SAC.

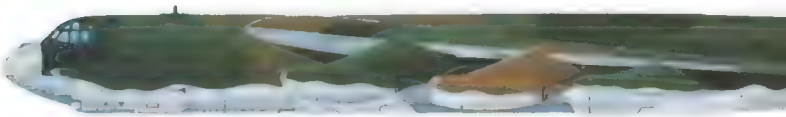
Development: Modifications and expensive upgrade programmes have kept the 30-year-old B-52 Stratofortress design in line with modern weapon delivery and attack techniques so that this impressive aircraft continues to be a valuable asset. Two variants remain in USAF service: the B-52G, of which 192 were built ▶

Above: Beneath the nose of this B-52G are the bulges of the EVS (Electro-optical Viewing System), just one of the many modifications which have given the legendary Boeing giant the ability to continue in service long after its quarter-century.

Left: B-52G 57-6518 prepares for take-off loaded with SRAMs underwing. These impressive aircraft are on standby 24 hours a day, every day, at SAC bases throughout the USA. The addition of Quick Start means that they can be airborne in minutes. Note the massive, fuselage-mounted main under-carriage.

Right: A B-52G Stratofortress makes its characteristic flat approach for landing. Boeing engineers helped to make the pilot's job easier at this stage of flight by building in large "barn door" flaps and spoilers to slow the aircraft down to an acceptable speed. The large plant at Wichita delivered 193 B-52G models between 1958 and 1961 before production switched to the B-52H. Identification features of the G compared with the F include a shorter fin, spoilers in place of ailerons for lateral control, a shortened nose radome and a remote tail gun position.

Above: This B-52G was used as a trials aircraft for advanced ECM equipment and is seen here contrailing dramatically at high altitude.



Right: Recognisable by the TF33 turbofan engines and their enlarged front cowls, this B-52H also has the low-level equipment fit and the 700-gallon underwing fuel tanks shown on the G version above.

with deliveries beginning in February 1959; and the B-52H, the final version, which has TF33 turbofans (giving an increased range of more than 10,000 miles) and improved defensive armament including a 20mm Vulcan multi-barrel gun and of which 102 were delivered from May 1961.

With the current attack philosophy being low-level, the big B-52s have been given an Electro-optical Viewing System (EVS). This is situated in blisters around the nose and uses forward-looking infra-red and low-light-level TV sensors to improve the aircraft's chances of getting to its target in any weather, day or night. Avionics improvements include ALQ-122 Smart Noise Operation Equipment and AN/ALQ-155(V) electronic countermeasures kit, satellite communications equipment, tail warning radar and ALQ-172 jammers. All are designed to help the aircraft survive against sophisticated enemy defences.

The "big punch" in the B-52's arsenal of weapons is the AGM-86B air-launched cruise missile (ALCM). Each G-force aircraft is initially being fitted with 12 ALCMs on underwing pylons, but a rolling programme will eventually see the B-52's bomb bay modified to accommodate eight weapons in a Common Strategic Rotary Launcher (CSRL). By early 1985 the USAF had 90 operational B-52Gs armed with the AGM-86B of a planned total of 105 aircraft. The first 33 H-force machines to be converted to this weapon are being worked on at Boeing, and SAC plans to have 96 operational by 1990, complementing the B-1B Wings. The key to the success of ALCM is the Offensive Avionics System now being installed in all B-52s. This sophisticated solid-state digital electronics ▶

Left: Camouflaged for the current low-level penetration role, this B-52G is fitted with FLIR/LLTV "bumps" around the nose.

package relays the planned ALCM mission to the missile's computer via connector cables between the B-52 and the missile. Mission tape cartridges contain the information on the launch profile, the simulated mission and data on all aspects of the flight.

Senior SAC officers say that the aircraft should be able to penetrate Soviet borders in wartime for at least the next five or six years, and with ALCM the B-52s would be able to attack targets from greater distances. The crews themselves are confident that with the constant ECM updates, decoy missiles, chaff and low-level (400ft, 125m) capability they can reach their missile launch points and have a good chance of returning to base or at least reaching friendly territory; besides, by the time the B-52s arrive at the Soviet border, the defences are expected to have been swamped by many other aircraft and not least by ICBMs.

In addition to ALCM, the B-52G/H can carry up to 20 AGM-69 Short Range Attack Missiles capable of striking targets up to 100 miles from the launch aircraft. To increase its range of weapon options, Boeing is to flight-test a stores management system in 1985 which will enable B-52Gs to carry conventional weapons such as bombs, mines and stand-off submunition-dispensing missiles. If successful, the retrofit of 69 aircraft will take place in the late 1980s.

Following some years as a limited sea reconnaissance aircraft in support of the US Navy, the B-52G is being modified to operate the AGM-84 Harpoon anti-ship missile. Present plans call for 30 aircraft to be so fitted, each capable of carrying twelve missiles. The two squadrons which will be assigned these aircraft will operate from Loring AFB, Maine, for Atlantic operations and Anderson AFB, Guam, to support the Pacific Fleet.

The current SAC Stratofortress fleet totals some 264 aircraft equipping fifteen Bomb Wings within the 8th and 15th Air Forces.

Right: A Boeing B-52G launches an AGM-86B Air-Launched Cruise Missile (ALCM) from its underwing rack. The small wings have deployed on the missile and the Williams turbojet will power it to its target many miles away. Although this effective weapon has only comparatively recently entered operational use, a more advanced version is now under development and will arm both the B-52s and B-1Bs towards the end of the 1980s. Whereas SRAM attracted almost no publicity when it was developed, ALCM is more emotive.

Left: A vital part of SAC's airborne strategic deterrent is the tanker fleet of KC-135s, one of which is seen here topping up a G series aircraft. These flying refuelling stations each have a maximum payload of 31,200 US gallons (118,100l) of fuel and, in theory at least, enable a B-52 to remain airborne indefinitely, although stress on the crew is a limiting factor. The KC force numbers just over 600 aircraft and to extend their lives and make them more "fuel efficient", some are being re-engined with four 22,000lb (9,979kg) thrust CFM56 turbofans.

British Aerospace AV-8 Harrier

AV-8A, C; TAV-8A

Origin: British Aerospace, Kingston-upon-Thames, Surrey.
Type: Land- or ship-based STOVL light attack aircraft.
Engine: One 21,500lb (9,752kg) thrust RR Pegasus 103 (P&W F402-402) vectored-thrust turbofan.
Dimensions: Span 25ft 3in (7·7m); length 45ft 8in (13·92m), (TAV) 55ft 9½ (17m); height 11ft 4in (3·43m), (TAV) 13ft 8in (4·17m); wing area 201·1 sq ft (18·68m²).
Weights: Empty 12,300lb (5,579kg), (TAV, with ballast) 13,300lb (6,033kg); max 25,000lb (11,340kg).
Performance: Max speed (clean, SL) 740mph (1,191km/h); dive limit Mach 1·3; radius (32·2°C day, 3,000lb, 1,361kg, ordnance, lo profile) 58 miles (93km) from VTO, 437 miles (703km) from 1,200ft, 366m, run.
Armament: All external. Provision for two 30mm Aden guns with 150 rounds each; two Sidewinder AAM pylons, plus normal weapon load of 3,000lb (1,361kg) on centreline and inboard pylons; max weapon load, including guns, 5,000lb (2,268kg).
History: First flight (P.1127) 21 October 1960, (GR.1) 28 December 1967; service delivery (AV-8A) 20 November 1970, (AV-8C) 1979.
User: USMC.

Development: "Air Forces operating fighter/attack aircraft of the conventional type find many reasons for not wanting to know about the Harrier. But having been settled for decades in fixed bases (which one can describe uncharitably as the Maginot Line doctrine of land-based tactical airpower), the Harrier's unique ability to survive and continue to operate independently of runways is seen by ▶

Above: Secured by tie-down chains, sombre-looking AV-8A Harriers of Marine Squadron VMA-512 sit aboard the USS *Tarawa* prior to a WestPac deployment in October 1980.

Below: To improve the efficiency of the AV-8A, 47 aircraft have been updated to AV-8C standard with lift-improvement devices, secure voice radio and improved UHF, a flare/chaff dispenser, night formation lights and a radar warning receiver. No 158387 shown here carries these improvements plus a refuelling probe.

Below: Home-based at MCAS Cherry Point, AV-8A 159241 was delivered in 1974 to VMA-231 and is shown in today's toned-down national markings.

such forces as the most unwelcome news." This statement by the Harrier's chief designer, John W. Fozard, was made in a lecture given to the Southampton Branch of the Royal Aeronautical Society in November 1976, and its sentiments ring as true today as they did then. Vertical/short take-off and landing (V/STOL) combat aircraft are still only in service with five countries, in spite of being effectively used (and combat-proven) during the Falklands War of 1982. The basic Harrier/Sea Harrier is operated by the UK, the USA, Spain and India, whilst the USSR flies its own more rudimentary design, the Yak-38 Forger.

One of the most enthusiastic operators of the Harrier is the US Marine Corps, who first looked at the aircraft in the late-1960s and found that it would be just the right kind of machine to provide quick-reaction close support in amphibious landing operations. It had ample radius for strikes around a beach-head, could fly from small, unprepared strips, and seemed capable of having a limited air defence mission with guns and missiles.

Designated AV-8A, the first USMC aircraft made its initial flight on 20 November 1970 and was air-freighted to the USA in March 1971. The first squadron, VMA-513, was formed in April at Beaufort MCAS, South Carolina, followed by VMA-542 and -231, and a training squadron, VMAT-203, all based at Cherry Point, North Carolina. The Marines ordered a total of 102 single-seat AV-8As and eight two-seat TAV-8A trainers, the final aircraft being delivered in 1977.

As the order was only agreed to by the American Government if it was "off-the-shelf", the Marine aircraft differed little from those flown by the RAF. Avionics changes had to be made to conform with US standards, and permament outboard wing pylons were fitted for carrying AIM-9 Sidewinder missiles. A Stencel ejection seat replaced the Martin-Baker Mk 9A, and a weapon-aiming computer was added to the Smiths HUD to increase accuracy for ground-attack sighting and lead-angle computing for the guns during air-to-air combat. The British 30mm Aden cannon were retained.

Experience with the AV-8A on operations has not been without its difficulties, and about half the force has been lost in accidents, due mainly to pilot inexperience in V/STOL flying combined with the aircraft's almost continuous low-level style of mission (which leaves little room for error). To maintain the Harrier's effectiveness, some 47 have been updated to AV-8C standard, which involves such modifications as the installation of an ALR-45 radar warning receiver (RWR), an ALE-39 chaff/flare dispenser in the rear fuselage, night formation lights and lift-improvement devices (LID) developed for the AV-8B.

The present AV-8s regularly deploy overseas to bases in the Mediterranean, Norway, the Philippines, South Korea and Japan, conducting exercises from

Below: 159380 is one of the eight TAV-8A trainers delivered to the USMC and is shown with the tall fin and in VMA(T)-203 markings.

amphibious assault ships and aircraft carriers. VMA-513, based at Yuma MCAS since 1976, is typical of the present Harrier units. It has about fifteen aircraft and eighteen pilots on strength, and on average the Harriers fly some 325 hours a month and achieve a sortie rate of the order of 300. Training activities on the squadron cover a wide range of V/STOL-related operations and include low-level tactical missions to deliver a great variety of ordnance and air-to-air defensive tactics which can imply medium-altitude viffing. This strange-sounding tactic involves quickly decelerating the aircraft from a fast forward speed by means of redirecting the engine nozzles downward and executing a sort of square turn and is seen as an effective way of dislodging an enemy fighter from the six o'clock position.

Below: A Marine pilot brings his Harrier in close to the photographic aircraft during a sortie in May 1981. Just behind his helmet can be seen the ejection seat handle and in front of the windscreen is a yaw vane indicator for use in the hover mode. The aircraft is in drab camouflage and has low-visibility markings.

Cessna A-37 Dragonfly

A-37B, OA-37B

Origin: Cessna Aircraft Company, Wichita, Kansas.
Type: Light attack aircraft.
Engines: Two 2,850lb (1,293kg) thrust GE J85-17A turbojets.
Dimensions: Span (over tanks) 35ft 10½in (10·93m); length (exc refuelling probe) 28ft 3¼ in (8·62m); wing area 183·9 sq ft (17·09m²).
Weights: Empty 6,211lb (2,817kg); loaded 14,000lb (6,350kg).
Performance: Max speed 507mph (816km/h); normal cruising speed (clean) 489mph (787km/h); initial climb 6,990ft (2,130m)/min; service ceiling 41,765ft (12,730m); range (max fuel, four drop tanks) 1,012 miles (1,628km), (max payload inc 4,100lb, 1,860kg, ordnance) 460 miles (740km).
Armament: GAU-2B/A 7·62mm Minigun in fuselage; eight underwing pylons (four inners 870lb, 394kg, each, next 600lb, 272kg, and outers 500lb, 227kg) for large numbers of weapons, pods, dispensers, clusters, launchers or recon/EW equipment.
History: First flight 22 October 1963.
Users: TAC, PACAF, ANG.

Development: Cessna's diminutive Dragonfly ranks as just about the smallest low-cost combat aircraft in the US Air Force. Its success in the attack role stems from the company's experience in designing "pilots' aeroplanes", easy to handle and with good responses and positive control, virtues which were particular- ▶

Above: Exercise "Bold Eagle 82" at Tyndall AFB was the location for this close-in view of a USAF A-37B Dragonfly.

Below: An A-37B at low level during a training mission. This small jet is now operated by the USAF as a forward air control aircraft because of its agility and the good view afforded by the broad canopy. It has replaced some OV-10s in this role.

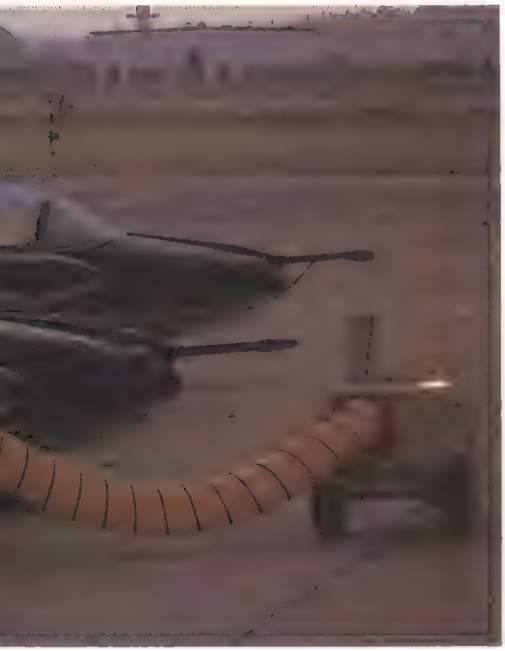
ly evident in the T-37 basic trainer, which was produced in large numbers for the USAF and became the basis for the development of the A-37.

The steady increase in guerrilla actions around the world was one factor that led the USAF to consider a less expensive "bomb truck" to meet a counter-insurgency requirement at the beginning of the 1960s. After all, it was hardly cost-effective to use one of the "Century-series" fighters to haul iron bombs across a few miles of territory to hit (or more likely miss) two or three dissidents in the jungle! So the YAT-37D evolved. The wings were strengthened and eventually accommodated eight underwing hardpoints, and a GAU-2 7·62mm Minigun with 1,500 rounds of ammunition was installed in the nose. The two crew members were given cockpit armour, the fuel tanks were made self-sealing and the undercarriage was beefed up to take the greater weight and to enable the aircraft to operate from rough forward airstrips.

Vietnam was the proving ground for the 39 A-37As built, and the experience gained was used to help produce the definitive A-37B, 550 of which were assembled before production ended in 1975. A refuelling probe was fitted in the nose, reticulated foam was added to the fuel tanks to protect against fire or explosion if hit by incendiary AA rounds, and the thrust line of the two J85 engines was moved slightly outwards and downwards to improve single-engine handling.

The Dragonfly proved highly successful during the latter stages of the Vietnam War, although even the most experienced pilot found survival difficult when the North Vietnamese brought large numbers of automatic AA weapons into the South. Some South Vietnamese Air Force A-37Bs were captured by the invading forces and were used by the North for some time after the Communist take-over.

Until recently, ex-USAF A-37Bs were employed by Air Guard and AFRES squadrons in the COIN role, but these aircraft have now been reassigned to the forward air control task under the new designation OA-37B. The type has replaced the much slower piston-powered O-2 Skymaster and currently equips the 110th Tactical Air Support Group, Battle Creek ANG Base, Michigan; the 111th TASG, Willow Grove NAS, Pennsylvania; and the 182nd TASG, Peoria, Illinois. During 1983–84, as part of the equipment modernisation of the USAF's



Left: Two A-37Bs of the Air Force Reserve undergo ground handling between missions. The side-by-side trainer origin of this design is plain, but the tactical camouflage adds a certain warlike appearance to what is one of the more attractive combat jets. With 550 built and only some 119 currently in USAF service, spare A-37s have found their way to a number of Central American and Asian air forces.

Below: A Reserve pilot pre-flights his aircraft. The A-37 lacks ejection seats, so to bail out in an emergency the crew have to step over the side of the cockpit.

Pacific Air Forces, the OA-37B replaced sixteen OV-10s of the 19th TAS Sqn. Osan AFB, South Korea, underlining the spirited performance of this little jet compared with the turboprop Bronco. Some OA-37s also equip the 602nd TAC Wing at Davis-Monthan AFB, Arizona, as part of the 12th Air Force, Tactical Air Command. There are currently 119 OA-37Bs in service with the USAF.

Fairchild A-10 Thunderbolt II

A-10A

Origin: Fairchild Republic Company, Farmingdale, New York.
Type: Close-support attack aircraft.
Engines: Two 9,065lb (4,112kg) thrust GE TF34-100 turbofans.
Dimensions: Span 57ft 6in (17·53m); length 53ft 4in (16·26m); height 14ft 8in (4·47m); wing area 506 sq ft (47m²).
Weights: Empty 21,519lb (9,761kg); forward airstrip weight (no fuel but four Mk 82 bombs and 750 rounds) 32,730lb (14,846kg); max 50,000lb (22,680kg); operating weight empty 24,918lb (11,302kg).
Performance: Max speed (max weight) 423mph (681km/h); cruising speed at sea level 345mph (555km/h); stabilised speed below 8,000ft (2,440m) in 45° dive at weight 35,125lb (15,932kg), 299mph (481km/h); max climb at basic design weight of 31,790lb (14,420kg), 6,000ft (1,828m)/min; service ceiling not stated; take-off run to 50ft (15m) at max weight, 4,000ft (1,220m); operating radius in CAS mission with 1·8h loiter and reserves, 288 miles (463km); radius for single deep strike penetration, 620 miles (1,000km); ferry range with allowances, 2,542 miles (4,091km).
Armament: One GAU-8/A Avenger 30mm seven-barrel gun with 1,174 rounds; total external ordnance load of 16,000lb (7,257kg) hung on eleven pylons, three side-by-side on body and four under each wing; several hundred combinations of stores up to individual weight of 5,000lb (2,268kg) with max total weight 14,638lb (6,640kg) with full internal fuel.
History: First flight (YA-10A) 10 May 1972, (production A-10A) 21 October 1975.
Users: TAC, PACAF, USAFE, ANG, AFRES.

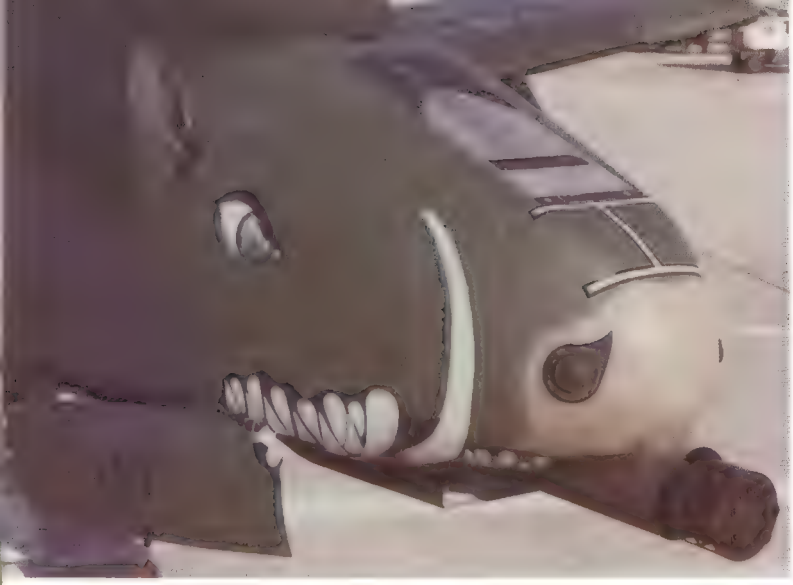
Above: The light grey paint scheme dates this shot as being in the mid-1970s. The strange petal aileron/deceleron at the wing tip is open and the trailing-edge Fowler flaps are out to slow the landing run. A single Maverick drill round hangs under the wing.

Right. The sole two-seat Night/Adverse Weather A-10 was developed as a private venture design to tempt the USAF. It first flew in May 1979 and, in addition to the two-seat cockpit, featured enlarged tail fins. Despite a good deal of investment, this project failed, but the all-weather/night capability will be conferred on standard A-10As by the addition of LANTIRN.

Above. This rear view of an A-10A loaded with eight Mk 82 bombs gives an excellent impression of the shielding effect the tailplane has on the hot exhausts of the two engines. Such a situation would certainly confuse the seeker head of an infra-red missile, just as Fairchild engineers had planned.

Development: The A-10A Thunderbolt is the US Air Force's principal fixed-wing anti-armour close air support aircraft. With a cockpit perched on a simple box-structure fuselage, two big fan engines aft and twin fins and rudders, this strange design takes no prizes for good looks, but its basic ugliness compared with most contemporary combat aircraft is the result of careful planning aimed at giving the A-10 as much chance as possible of surviving over the battlefield.

Fairchild engineers designed the A-10 to meet a USAF requirement stemming from experience in the Vietnam War and calling for a heavily armoured anti-tank aircraft capable of carrying a weighty ordnance load over long distances. The result was a rugged aircraft with eleven ventral weapons pylons and a tank-killing GAU-8 30mm multi-barrel cannon in the nose capable of disabling most current Soviet AFVs. In cases of ground-fire damage or spares problems, cer- ▶



Above: External avionics pods on a 354th TFW A-10 at Myrtle Beach AFB. The Pave Penny laser seeker pod under the nose is offset to avoid the effects of gun blast; in the foreground is an ALQ-119 jamming pod which is normally carried on the outboard starboard wing pylon.

Right: This Thunderbolt was given a coat of white paint in a disruptive pattern for evaluation purposes during Exercise "Cool Snow Hog 82-1", held at Kotzebue Air Station, Alaska. The aircraft is from the 18th TFS, 343rd Composite Wing, at Eielson AFB, and provides support for US Army units in the region.

Above: An 81st TFW A-10A seen prior to ferrying to the UK. On the inboard pylons are 600 US gall (2,273l) drop tanks.

Left: Effective Warthog nose art on a 917th TFG Thunderbolt. On top of the nose is the air refuelling position and the markings used for guidance by the "flying boom" operators of KC-135s.

tain parts of the structure, such as the flaps, main undercarriage units and movable tail surfaces, are interchangeable. Both the tail unit and the fuselage act as partial shields for the two engines, reducing their infra-red signature and lessening the probability of a hit by a heat-seeking missile.

The A-10's main theatre of operations is in Europe, where more than 100 are based. From their two main UK airfields at Bentwaters and Woodbridge, the aircraft of the six squadrons that form the 81st Tactical Fighter Wing are regularly deployed to a number of Forward Operating Locations (FOL) in West Germany. In peacetime, four FOLs are used, Sembach and Leipheim in the north with the 2nd Allied Tactical Air Force, and Ahlhorn and Norvenich in the south with the 4th ATAF. A further two FOLs would be activated in wartime.

Survivability is the key to successful A-10 operations, and the aircraft is intended to work with as little external support equipment as possible. Apart from the unique cannon loading system, the A-10 is able to sit on the ground during turn-rounds using one engine or its APU to keep its systems alive. Then, loaded with Maverick ASMs or Rockeye cluster bombs, an A-10 can fly for 30 minutes to the target area and operate for an hour hunting in packs of, say, four aircraft, responding to calls from ground controllers and co-operating with US Army AH-1 Cobra gunship helicopters in co-ordinated attacks on ▶

Right: Most A-10A Thunderbolt IIs are painted in European 1 three-colour camouflage like this Warthog of the 23rd TFW at England AFB, Louisiana.

Below: Night falls and the USAF prepares to fly another evaluation mission with the two-seat all-weather/night version of the A-10. The aircraft was not selected for production.

Below: Two "hogs" looking for trade! A-10As of the 354th TFW, Myrtle Beach, fly in company, the nearest machine armed with "iron" bombs and the other carrying Maverick anti-armour missiles.

enemy armour. Enhancing the aircraft's capability is the Pave Penny laser target designator pod fitted below the cockpit, while future equipment will include a LANTIRN fire control pod to improve night/bad weather capability.

In 1983, HQ TAC issued a Statement of Need for all fighter/attack aircraft to be upgraded with self-defence AIM-9L Sidewinder air-to-air missiles, and trials were flown with the A-10 which showed that the addition of this weapon would greatly enhance the aircraft's chances of surviving in combat. The A-10 will begin receiving the missile in 1985, either single or twin launchers being carried.

The A-10 has few vices, and is capable of positive control response when manoeuvring at low level. Aircrew fly it from 1,000ft (300m) down to 50ft (15m) in one-mile visibility along valleys, round hills, and among the trees across the flat plains of Central Europe. It is not a fast aircraft: it cannot be if pilots are to acquire a target visually and attack it. In an ideal situation, a tank can be picked up at a range of 6,000ft (1,800m) by an A-10 flying at around 300–350kts, and a burst of 30mm would reach the target in 2·3 seconds. SAMs and radar-directed AA guns are the A-10's biggest enemies, followed by opposing fighters and armed helicopters. Critics of the aircraft have said that its chances of survival in a European war would be almost nil, yet its basic simplicity and strength of numbers could be its advantages — and, on the battlefield, it would not be alone.

A-10 Thunderbolts are also operated by the 18th TFS at Eielson AFB, Alaska, and by the 25th TFS at Suwon, South Korea. In the USA, five Air National Guard and five Air Force Reserve tactical fighter squadrons are equipped. Production ceased in 1983 with the delivery of the 713th aircraft.

General Dynamics F-16 Fighting Falcon

F-16A, B, C, D

Origin: General Dynamics Corporation, Fort Worth, Texas.
Type: (F-16A, C) Multi-role fighter, (B, D) operational fighter/trainer.
Engine: One 23,840lb (10,814kg) thrust P&W F100-200 afterburning turbofan or one GE F110 turbofan.
Dimensions: Span 31ft (9·45m), (over wingtip missiles) 32ft 10in (10·01m); length (all, exc probe) 47ft 7¾in (14·52m); height 16ft 5½in (5·01m); wing area 300 sq ft (27·87m²).
Weights: Empty (A) 15,137lb (6,866kg), (B) 15,778lb (7,157kg); loaded (AAMs only) (A) 23,357lb (10,594kg), (B) 22,814lb (10,348kg); max external load (A, B) 35,400lb (16,057kg), (C, D) 37,500lb (17,010kg).
Performance: Max speed (AAMs only) 1,350mph (2,173km/h, Mach 2·05) at 40,000ft (12,190m), max at sea level 915mph (1,472km/h, Mach 1·2); initial climb (AAMs only) 50,000ft (15,240m)/min; service ceiling over 50,000ft (15,240m); tactical radius (A, C, six Mk 82, internal fuel, hi-lo-hi) 340 miles (547km); ferry range 2,415 miles (3,890km).
Armament: One GE M61A-1 20mm gun with 515 rounds; centreline pylon for 300 US gal (1,136l) drop tank or 2,200lb (998kg) bomb, inboard and middle wing pylons for 3,500lb (1,587kg) each, outer wing pylons for 250lb (113·4kg).
History: First flight (YF-16) 20 January 1974, (production A) 7 August 1978; service delivery (A) 17 August 1978.
Users: TAC, PACAF, USAFE, ANG, AFRES, USN.

Development: As a pure fighting machine, the F-16 has few if any equals. Among the world's current fighter aircraft it would be safe to term it a "hot rod", designed in the best traditions of America's finest dog-fighters such as the P-51 Mustang and F-86 Sabre. In competitions the F-16 has almost always been on the winning side, first being selected as the USAF's future lightweight fighter in 1975 and later successfully winning the competition for Europe's ▶

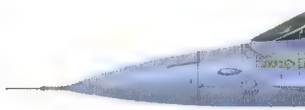
Above: F-16A Fighting Falcons in dedicated interceptor guise armed with wingtip-mounted AIM-9L Sidewinder air-to-air missiles. Without doubt this aircraft can be considered to be one of the great success stories in aviation over the last decade, with present order prospects approaching the 3,000 mark, for fourteen countries.

Below: One of the first block F-16A Fighting Falcons was used in 1981 for the initial evaluation trials of the Hughes AIM-120 AMRAAM (Advanced Medium Range AAM) which is due to replace the present AIM-7 Sparrow. Despite problems with this weapon system which were highlighted early in 1985, it is expected that the missile will enter service with USAF F-16C/D aircraft in 1986.

multi-role fighter to replace the F-104. Consequently production lines were set up in the Netherlands and Belgium, supplementing those at General Dynamics' large plant at Fort Worth, Texas; it is planned to establish a further assembly line in Turkey to meet that country's order for 160 F-16s.

The success of the F-16 as a combat aircraft is due mainly to advances in aerospace technology. Weight – one of the designer's biggest problems – has been reduced considerably through the use of light composite materials, whilst the prominent wing/body flare enhances lift at high angles of attack. The hinged leading and trailing edge flaps on the straight wing are used to increase manoeuvrability in combat (the trailing surfaces being rapid-action flaperons), and a futuristic cockpit has a reclining zero-zero ejection seat to resist high g forces and a sidestick controller instead of the conventional central column. The controls are electronically signalled by a fly-by-wire system, and the avionics are all-digital, being integrated through a multiplex system which has reduced the amount of wiring needed in the aircraft. In the nose is an APG-66 multi-mode intercept radar with a clutter-free look-down capability. A head-up display (HUD) presents the pilot with all the vital information he needs without constantly referring to instruments in the cockpit. For armament, the F-16 has a 500-round 20mm gun in the left-hand side of the fuselage and two wingtip-mounted AIM-9 ▶

Right: Another F-16A in the markings of the 8th TFW based in South Korea. The superb view from the pilot's position is obvious and all the controls he needs during air combat are located on the control "stick" and throttle situated on the side consoles of the cockpit. In front of him is a Head-Up Display unit giving all the vital information.



Above: An F-16A of the USAF 8th TFW "Wolf Pack" based at Kunsan AB, South Korea. The deployment of these multi-role aircraft to this area in 1981 gave the Pacific Air Forces an immediate technical advantage over the equipment in service with the North Korean Air Force. This latter comprises MiG-21 fighters, which would be hard put to gain any success in a dogfight with F-16s. South Korea will receive 36 Falcons from 1986.

Left: His mount displaying the wolf head of the 8th TFW, a lead F-16 pilot and his wingman close up for the benefit of the camera; for combat the separation would be much greater and the wing-tip missile pylons would be loaded. At the tip of the fin is the tail warning radar and between the engine nozzle and the tailplane is the top segment of the airbrake. These aircraft are powered by the F100 turbofan.

Sidewinder missiles. More stores, comprising bombs, rockets, missiles, ECM pods or fuel tanks, may be carried underwing.

The USAF has contracted to buy more than 1,000 F-16s to date, but intends to purchase 2,651 aircraft to swell the number of tactical fighter wings and provide a balanced force supplementing the long-range F-15 interceptors. USAF Commands equipped with the aircraft comprise TAC, with units based in the USA; PACAF, with the 8th TFW in Korea and another wing forming in Japan during 1985; USAFE, with the 50th TFW in Germany and 401st TFW in Spain; the ANG, with two Groups attached to TAC; and the Air Force Reserve, with a squadron at Hill AFB, also attached to TAC.

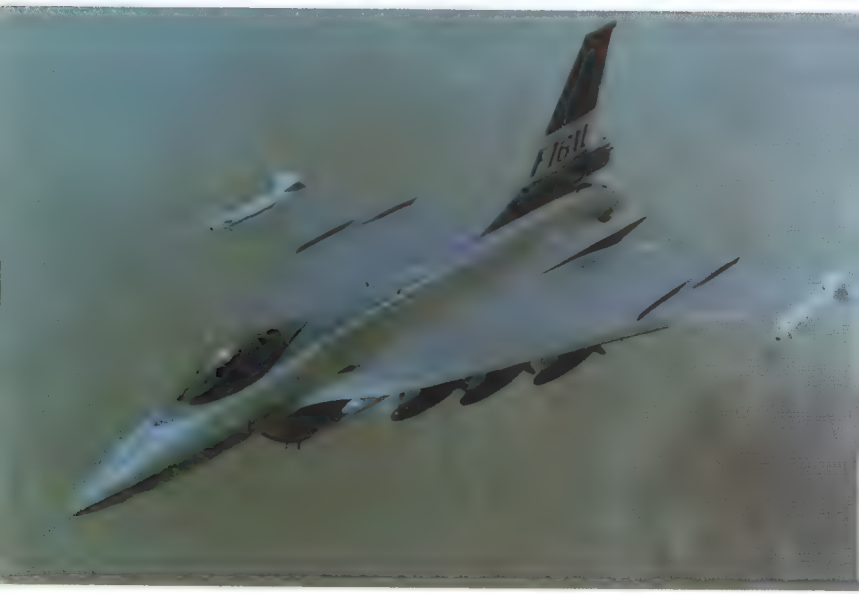
In December 1984 the first single-seat F-16C and two-seat D entered operational service with the USAF. These versions have succeeded the original F-16A and B respectively and are the product of a multi-stage improvement programme which introduces the APG-68 radar with increased detection range, track-while-scan capability and high-resolution ground mapping; from 1986, the AIM-120 AMRAAM "fire-and-forget", beyond-visual-range, air-to-air missile will arm the F-16C/D, and a year later the first LANTIRN nav/attack pods will be delivered for use with the AGM-65D IR Maverick missile. A change in the powerplant for 110 F-16C/Ds is planned, the existing F100 being replaced by the General Electric F110 turbofan; an improved F100 will be fitted to the remaining aircraft. Early in 1985 the US Navy announced that it had selected the F-16C to operate in the air combat adversary role. Given the designation F-16N, fourteen aircraft, powered by the F110 engine, will be delivered.

Although the F-15E Strike Eagle won the Air Force's dual-role fighter competition, the competing F-16E (previously designated F-16XL) can hardly be said to have failed totally; instead, the USAF has requested that development of this version be continued as the F-16F for possible future acquisition . A company- ▶

Above: Ground crew heave a Sidewinder AAM on to the wing-tip launch rail of an F-16. On the ground in the left of the picture can be seen a multiple ejector rack which is designed to carry a variety of different bombs with common pick-up points. The rack itself is fixed to the aircraft's underwing pylon and allows for a greater number of weapons to be carried.

Left: The USAF's famous aerobatic and demonstration team, the *Thunderbirds,* use these flamboyantly painted F-16s. The aircraft's stable flying characteristics and its ability to turn on a nickel make it an ideal candidate for this type of close-formation flying. Note that these machines have the enlarged tailplanes introduced to match the increased gross weight of later production aircraft. The *Thunderbirds* received their aircraft during 1982 in place of the earlier T-38 Talons.

Right: The two-seat F-16B has the same overall dimensions as the single-seat version, the second cockpit displacing just under 200 US gallons of fuel. GD designed the rear cockpit to be stepped just enough for good instructor view without a periscope. As this aircraft from the Air Force Systems Command illustrates, the B is a dual-capability machine, able to fight and train depending on the requirement.



Right: Trials have been conducted with this Full Scale Development F-16 (75-0750) which has been modified for the Advanced Fighter Technology Integration (AFTI) programme. A new flight control system, large canted canard controls and a deeper dorsal spine combine to investigate flight manoeuvres made in any direction without the prior need to point the aircraft in that direction. For example, with wings level, the canards enable the aircraft to be turned without banking — potentially a great advantage for the fighter pilot. The programme is well into its stride and future F-16 developments will no doubt incorporate AFTI results.

sponsored project, the F-16F incorporates a distinctive, cranked arrow wing which gives increased range, greater weapons load, higher speeds and improved manoeuvrability. Also known as SCAMP (Supersonic Cruise Aircraft Modification Program), the new aircraft has a fuselage length increased by 4ft 8in (1·4m) to blend in the new wing, but the design retains some 93 per cent commonality with the current F-16 airframe and 91 per cent commonality with the existing avionics. Another experimental F-16 which could see USAF service is a two-seat Wild Weasel for electronic jamming and anti-radar use.

To date, the USAF has not employed the F-16 in combat, but the aircraft has acquitted itself well in the hands of Israeli pilots on a number of occasions. The first was in June 1981 when the type accompanied F-15s to bomb a nuclear reactor in Iraq; at that time Israel had received 53 of its initial order for 75 F-16s. In 1983 and 1984, Israeli F-16s achieved a marked ascendancy over Syrian MiGs during battles over the Lebanon, one aircraft shooting down four opponents in a single sortie.

Left: A contender for the USAF Enhanced Tactical Fighter competition, the F-16XL gained second place to the F-15E but was judged to be so outstanding that development is continuing for likely USAF use in the 1990s. To produce the XL, GD lengthened the fuselage to 54ft 1.86in (16.51m) and grafted on a cranked-arrow wing incorporating carbon composite materials to save weight. Up to seventeen stores stations are fitted, and the XL's performance is markedly better in many flight regimes than that of the standard F-16.

General Dynamics F-106 Delta Dart

F-106A, B

Origin: General Dynamics Convair Division, San Diego, California.
Type: (F-106A) All-weather interceptor, (B) operational trainer.
Engine: One 24,500lb (11,130kg) thrust P&W J75-17 afterburning turbojet.
Dimensions: Span 38ft 3in (11·67m); length (both) 70ft 8¾in (21·55m); wing area 661·5 sq ft (61·52m²).
Weights: Empty (A) about 24,420lb (11,077kg); loaded (normal) 34,510lb (15,668kg).
Performance: Max speed (both) 1,525mph (2,455km/h, Mach 2·3) at 36,000ft (11,000m); initial climb about 29,000ft (8,840m)/min; service ceiling 57,000ft (17,375m); range with drop tanks 1,800 miles (2,900km).
Armament: One 20mm M61A-1 gun; two AIM-4F plus two AIM-4G Falcons, plus one AIR-2A or -2G Genie nuclear rocket.
History: First flight (aerodynamic prototype) 26 December 1956, (B) 9 April 1958; squadron delivery June 1959.
User: ADTAC.

Development: The Delta Dart is gradually approaching the end of its operational life, having served for more than 25 years as the principal air defence interceptor in the continental USA. When it entered service with the 498th FIS at Geiger AFB, Washington, in October 1959, the F-106 was one of the highest-performance fighters in the world, with a speed of Mach 2·3 (1,525mph, 2,455km/h) at altitude.

The F-106 was a development of the F-102 Delta Dagger and suffered from a number of delays and shortcomings associated with the J75 engine and the Hughes MA-1 electronic control system, so much so that at one stage the USAF contemplated cancelling the programme altogether; however, a reduced production run of 340 aircraft – 277 single-seat F-106As and 63 tandem-seat F-106Bs – was finally approved, instead of the original 1,000 machines. With most of the bugs ironed out, the F-106 more than met the performance requirements of Air Defense Command.

Above: The last remaining Delta Dart squadrons are on their way out and with them will go one of the oldest combat aircraft in the USAF. A two-seat F-106B from Tyndall AFB, Florida, is shown here.

The Dart originally carried an all-missile armament of Genie and Falcon air-to-air weapons, but the Vietnam War re-wrote the fighter tactics manuals and guns were put back into the air, with the result that most of the F-106s on strength were fitted with a 20mm cannon neatly recessed into the underside of the fuselage to supplement the missiles. To extend patrol time, the aircraft was also given an in-flight refuelling receptacle mid-way along the top of the fuselage for use with KC-135 "flying boom" tankers.

The last F-106 was delivered in 1961 and, rather surprisingly, no direct replacement design was ordered, despite the continuing threat of the manned bomber. ADCOM was disbanded in 1980, and the surviving F-106 units were transferred to Air Defense TAC (ADTAC). There are currently seven ADTAC and Air Guard units flying F-106s, but their role is being increasingly taken over by F-15 Eagle squadrons and it will not now be long before the Delta Dart disappears entirely from the USAF's inventory.

Left: Two operational F-106A Delta Darts formate with a YF-16 prototype. The extension at the base of the fin is for the braking parachute and the bulge in front of the cockpit is an IR sensor. The F-106 is the last of the famous "Century Series" warplanes and is the last pure interceptor to operate with the USAF. It still holds the world air speed record for single-engine aircraft — a distinction gained more than a quarter of a century ago. F-15 Eagles are steadily replacing the Delta Darts that are still in service.

General Dynamics F-111

F-111A, D, E, F; FB-111A; EF-111A

Origin: General Dynamics Corporation, Fort Worth, Texas; (EF-111A) Grumman Aerospace Corporation, Bethpage, NY.
Type: (A, D, E, F) all-weather attack aircraft, (FB) strategic attack aircraft, (EF) tactical ECM jammer.
Engines: Two P&W TF30 afterburning turbofans as follows: (A, C, EF) 18,500lb (8,390kg) TF30-3, (D, E) 19,600lb (8,891kg) TF30-9, (FB) 20,350lb (9,231kg) TF30-7, (F) 25,100lb (11,385kg) TF30-100.
Dimensions: Span (fully spread) (A, D, E, F, EF) 63ft (19·2m), (FB) 70ft (21·34m), (fully swept) (A,D,E,F,EF) 31ft 11½in (9·74m), (FB) 70ft 11in (10·34m); length (except EF) 73ft 6in (22·4m), (EF) 77ft 1½in (23·51m); wing area (A, D, E, F, EF, gross, 16°) 525 sq ft (48·77m²).
Weights: Empty (A) 46,172lb (20,943kg), (D) 49,090lb (22,267kg), (E) about 47,000lb (21,319kg), (EF) 53,418lb (24,230kg), (F) 47,481lb (21,537kg), (FB) close to 50,000lb (22,680kg); loaded (A) 91,500lb (41,500kg), (D, E) 92,500lb (41,954kg), (F) 100,000lb (45,360kg), (FB) 114,300lb (51,846kg), (EF) 87,478lb (39,680kg).

Performance: Max speed at 36,000ft (11,000m) clean and with max afterburner, (A, D, E) 1,450mph (2,335km/h, Mach 2·2), (FB) 1,320mph (2,124km/h, Mach 2), (F) 1,653mph (2,660km/h, Mach 2·5), (EF) 1,160mph (1,865km/h, Mach 1·75), cruising speed (penetration) 571mph (919km/h); initial climb (EF) 3,592ft (1,095m)/min; service ceiling at combat weight, max afterburner, (A) 51,000ft (15,500m), (F) 60,000ft (18,290m), (EF) 54,700ft (16,670m); range with max internal fuel (A, D) 3,165 miles (5,093km), (F) 2,925 miles (4,707km), (EF) 2,484 miles (3,998km); take-off run (A) 4,000ft (1,219m), (F) under 3,000ft (914m), (FB) 4,700ft (1,433m), (EF) 3,250ft (991m).
Armament: Internal weapon bay for two B43 bombs or (D, F) one B43 and one M61 gun; three pylons under each wing (four inboard swivelling with wing, outers being fixed and usable only at 16°, otherwise being jettisoned) for max external load 31,500lb (14,288kg); (FB only) provision for up to six SRAM, two internal; (EF) no armament.
History: First flight 21 December 1964; service delivery (A) June 1967, (EF) July 1981.
Users: (FB) SAC; (E, F, EF) TAC, USAFE. ▶

Below: Two early F-111As in the markings of the 428th TFS, 474th TFW, from Nellis AFB, each carrying 24 Mk 82 bombs known as "slicks".

Above: This view of an early 474th TFW F-111A accentuates the strange upturned nose shape which prompted the nickname "Aardvark". The black lines on the upper surface of the wings and fuselage are guides for maintenance personnel and indicate areas outside which they should not tread.

Development: If the United States Air Force in Europe is ever called upon to fly retaliatory attack missions against the Soviet Union following a first strike from the East, the principal tactical air weapon used will be the General Dynamics F-111. Day or night, sunshine or snow, nearly 200 of these remarkable aircraft flying from airfields in the UK would undertake low-level bombing missions against targets in the western USSR and the bordering Warsaw Pact countries. Together with the Tornado, the F-111 remains the only aircraft capable of this type of operation available to NATO and seems likely to occupy this position for some years. Yet in its infancy this advanced design seemed destined never to overcome a whole string of problems which attracted the attention of the world's press and called into question the political decisions that forced the programme through to a conclusion.

Backing the TFX (Tactical Fighter Experimental) programme, the US Department of Defense directed that one design was to fulfil all the fighter and attack needs of the Air Force, Navy and Marine Corps, despite the different requirements of these services. General Dynamics won the contract, and the prototype F-111 flew on 21 December 1964. Serious development problems followed, involving an increase in weight, excessive aerodynamic drag and engine inlet difficulties, compounded by a number of in-flight structural failures. The Navy F-111B programme was cancelled in 1968 and an order for 24 F-111Cs for the Royal Australian Air Force was temporarily shelved until urgent modifications were incorporated in the aircraft; delivery of these would be made in 1973. ▶

Top: A gun-equipped F-111D of the 27th TFW landing at Cannon AFB. A total of 96 D series aircraft were delivered to the Wing, these machines incorporating a KB-18A automatic strike camera which looks obliquely ahead from a position under the forward fuselage.

Above: This D displays its complicated wing geometry, in particular the slat along the leading edge and the glove vane and pivot junction in the minimum-sweep position. The pilot controls the wing-sweep angle with a handle on the left-hand side of the cockpit. The weapon pylon seen here also pivots as the wing sweeps.

Left: Release of a Short Range Attack Missile (SRAM) over the White Sands Range. This weapon is currently the main armament of the long-span FB-111A, two being carried in the bomb bay and four under the wings. Each missile weighs about a ton (1,000kg).

To prove that the F-111A could function effectively in the attack role (the fighter task had been impossible to meet because of the aircraft's poor power-to-weight ratio), the USAF deployed six F-111As to Thailand in mid-1968 for operations against North Vietnam. The loss of three of these aircraft shortly after their arrival clouded what was in fact a vindication of the GD design. Courageous Air Force crews pioneered terrain-following missions across unknown country during the blackest of nights, often in the worst weather that South-East Asia could provide, flying over hills, round mountains and along steep-sided valleys, holding a steady 200ft (90m) above the ground at high subsonic speed, and finally precision-bombing a target to within feet of the aiming point. The crew, snug in their jettisonable cockpit capsules, would then return to more hospitable environments, having caught the ground defences unawares and having been undetected by the early warning radars ringing the northern borders.

A total of 141 F-111As were built, and these equip the 366th TFW at Mountain Home AFB, Idaho; 42 of these are being converted into EF-111A electronic warfare aircraft for service with the 390th Electronic Combat Sqn at Mountain Home and the 42nd ECS at Upper Heyford in the UK. Some of the shortcomings in the initial production variant were rectified in the F-111E, of which 94 were built, the survivors serving with the 20th TFW at Upper Heyford; this aircraft has larger intakes and more powerful engines, which have improved performance ▶

Above: Four Paveway II laser-guided bombs hang under the wings of this F-111F from the 48th TFW; under the fuselage is a Pave Tack pod.

Below: An F-111F of the 48th TFW based at RAF Lakenheath, UK, pictured in December 1982 and carrying a practice-bomb dispenser.

above Mach 2·2. The out-of-sequence F-111D was an attempt further to improve weapons delivery and navigation, the 96 machines being assigned to the 27th TFW at Cannon AFB, New Mexico.

What is generally recognised to be the best of the breed is the F-111F, which equips the 48th TFW at Lakenheath, UK. Two 25,100lb thrust TF30 turbofans replace less powerful engines, but the key to this aircraft's success is the addition of the Pave Tack system. This is located in the belly of the F-111F and provides a day/night, all-weather capability to acquire, track, designate and hit surface targets using electro-optical, infra-red or laser guided weapons. A recent addition to the F-111's armoury is the French Durandal parachute-retarded, rocket-boosted, runway-attack bomb. Delivery to the squadrons began in 1984, and each aircraft is able to carry up to twelve of these weapons. Although its dogfight capabilities are considered to be minimal, UK-based F-111E/Fs are now fitted with AIM-9L Sidewinder air-to-air missiles for self-defence and an ALQ-131 ECM pod under the rear fuselage.

Ordered as a replacement for the Convair B-58 Hustler and early models of the B-52, the FB-111A looks almost identical to the tactical versions but incor-

Left: Soft evening light catches the low-voltage night formation strips on this 48th TFW F-111F. The strips have been applied to most US tactical aircraft. Under the wing is a multiple bomb carrier and a practice dispenser. The F variant is the most potent F-111, with the ability to operate in any weather, day or night — and deliver its ordnance in these conditions, thanks to the installation of the Pave Tack target acquisition system.

porates a wingspan increase of 7ft (2·13m) to extend range and to provide room for additional outer pylons. The original procurement of 210 machines was cut back to 76 because of increased costs, and these aircraft operate with SAC's 380th BW at Plattsburgh AFB, New York, and the 509th at Pease, New Hampshire. Packed into the airframe is a Mk IIB all-digital, computer-controlled avionics system derived from that in the F-111D, Doppler and terrain-following radars, an optical display sight and a low-altitude radar altimeter set. Class IV modifications to much of the FB-111A's systems will enable SAC to retain the type in service throughout the 1990s. A strengthened structure and landing gear enables the FB variant to carry greater weapon loads than its tactical partners, including up to four AGM-69A SRAM missiles underwing plus two more in the bomb bay, or six nuclear bombs, or up to 31,500lb (14,300kg) of conventional bombs.

Below: An FB-111A bomber assigned to the Second Air Force, Strategic Air Command.

Left: The EF-111A Raven is currently the hottest commodity flying in the electronic warfare role. It is designed to find, identify and interfere with enemy emitters. To do this the Raven is packed with internal and external receivers, the most obvious in this view being the large fin tip pod and the two small fairings on the side of the fin.

Grumman A-6 Intruder

A-6E, A-6E TRAM, EA-6A

Origin: Grumman Aerospace, Bethpage, New York.
Type: Two-seat carrier-based all-weather attack aircraft.
Engines: Two 9,300lb (4,218kg) thrust P&W J52-8B turbojets.
Dimensions: Span 53ft (16·15m); length 54ft 7in (16·64m); height 16ft 3in (4·95m).
Weights: Empty 26,746lb (12,132kg); max take-off weight 58,600lb (26,580kg); max carrier landing weight 36,000lb (16,329kg).
Performance: Max speed 644mph (1,037km/h) at sea level; max climb rate 7,620ft (2,323m)/min; service ceiling 42,400ft (12,925m); range with full combat load 1,011 miles (1,627km); ferry range 2,735 miles (4,401km).
Armament: Five stores pylons each rated at 3,600lb (1,633kg) with max total load of 18,000lb (8,165kg); can carry any of more than 30 types of bombs, rockets, missiles, mines or fuel tanks; Harpoon anti-ship missile recently added to weapons complement (six per aircraft).
History: First flight (YA2F-1) 19 April 1960, (A-6E) 10 November 1970, (A-6E TRAM) October 1974; service entry (A-6A) 1 February 1963.
Users: USN, USMC.

Development: As the Navy's primary medium attack aircraft, the A-6 Intruder has proved itself to be just about the best of the world's carrier-based bombers; however, built by a company renowned for producing a long line of strong "cats", it can hardly be called the most modern of combat aircraft, since it was conceived in the late 1950s and entered US Navy service in February 1963, more than two decades ago. It then played a significant role in South-East Asia, operating from pitching carrier decks in the Gulf of Tonkin against enemy targets in the darkest of nights and the dirtiest of weather when the only other types likely to be about were the modest number of USAF-operated F-111As.

Because of the space problem on aircraft carriers, the Intruder's size was kept small, with the result that all ordnance had to be mounted externally, thus incurring certain drag penalties. However, the aircraft's amazing range/payload capabilities more than outweighed the drag problems when the Navy found they could fly hi-lo-hi with a full load of fuel and bombs to a target nearly 1,000 miles away from base – and all this with an aircraft that weighed almost as much as a World War II heavy bomber! ▶

Below: Three A-6E Intruders of Marine attack squadron VMA(AW)-332 based at Cherry Point, NC, seen from a fourth A-6. Such is the effectiveness of the design that the Navy plans to retain the Intruder in active service until the late 1990s.

The present Intruder/Prowler family is made up of the A-6E and A-6E TRAM; the EA-6A and -6B dedicated jamming variants; and the KA-6D, an air refuelling tanker variant with an attack capability. Recognisable by the small turret under the nose, the A-6E TRAM (Target Recognition Attack Multisensor) is the main Navy/Marine Corps attack version and has the capability of striking at targets in all weathers, using TV-type imagery for greater accuracy. Within the bulbous nose radome is a Norden APQ-148 multi-mode radar which provides simultaneous ground mapping, identification, tracking and rangefinding of fixed and moving targets. A display in the cockpit presents a high-resolution image from forward-looking infra-red, allowing the delivery of both conventional and laser-guided weapons.

In the future, the Intruder line will continue with the yet-to-fly enhanced A-6E, which the Navy sees as its main carrier-based all-weather attack aircraft for service until the late 1990s. The choice of yet another Intruder upgrade was dictated by the relatively low cost involved compared with developing a brand new design, added to which was the growth potential of Grumman's bomber. Basically, the new aircraft is a modernised A-6E TRAM and in external appearance will be almost identical. Aerodynamically, however, the aircraft, which will probably carry the designation A-6F, will have a modified inboard ▶

Top: An A-6E Intruder from the USS *Ranger* carrying a Pave Spike pod under the fuselage. Side-by-side seating in the Intruder saves aircraft length, a vital factor in shipboard stowage.

Above: Although it looks cumbersome, the angled refuelling probe on the Intruder's nose neither restricts the pilot's view nor gives aerodynamic problems. Here an A-6 refuels from a KA-6D tanker. The USN adopted the flexible hose and drogue system instead of the fixed boom.

Left: Carrying the tail code of a Pacific Fleet unit, this KA-6D carries bombs on the underwing pylon, indicative that the tanker version also has an attack capability.

slat on the wing leading edge and the adjacent glove vane. This will increase the Intruder's "bring back" weight by reducing its landing speed by 8–10kts, and will also allow the aircraft to land on carrier decks whilst it is still loaded with ordnance, instead of having possibly to jettison expensive "smart" weapons to gain a permissible landing weight. Also noticeable on the enhanced E will be the addition of AIM-9 Sidewinder AAMs or AMRAAMs on extra outboard underwing pylons. As well as to give the A-6 a measure of self-defence during an attack sortie, the Navy plans to use this enhancement to supplement the air defence umbrella over a carrier battle group.

Under the skin, however, the new aircraft is a different beast. A new radar (yet to be chosen) will have sharper resolution, longer range and an air-to-air mode. The cockpit displays will be almost identical to those in the F-14 Tomcat, whilst the highly efficient AYK-14 tactical computer will be installed. A new engine will be fitted, the choice lying between the 11,200lb (5,080kg) thrust P&W J52-408 and the 10,500lb (4,760kg) GE F404-404, and an APU will be installed, eliminating the need for external power sources when landing away from the parent carrier.

The standard US Carrier Air Wing includes one medium attack squadron with ten (or sometimes eleven) A-6Es and four KA-6D tankers. There are currently (1985) thirteen active Carrier Air Wings in the US Navy, with a further Wing due for activation in 1988 when *Theodore Roosevelt* (CVN-71) enters service. Intruder units presently operational include VA-34 (*America*), VA-145 (*Kitty Hawk*), VA-75 and -85 (*John F Kennedy*), VA-115 (*Midway*), VA-176 (*Independence*), VA-65 (*Dwight D Eisenhower*), VA-35 (*Nimitz*), VA-165 (*Ranger*), VA-95 (*Enterprise*), VA-196 (*Constellation*), VA-52 (*Carl Vinson*), VA-55 (*Coral Sea*) and VMA(AW)-533 (*Saratoga*).

Above: A fine view of an Atlantic Fleet-based A-6. Almost all the Intruder's interior wing accommodates fuel, and recent fatigue problems are unlikely to alter this design feature.

Below: Under the nose of this VA-65 "Tigers" aircraft is the TRAM turret, the main identification feature of the latest operational version of the Intruder, the A-6E TRAM. The Target Recognition Attack Multi-sensor gives the aircraft the ability to strike targets in any weather and enhances the capability of an already potent warplane.

Grumman F-14 Tomcat

F-14A, D

Origin: Grumman Aerospace, Bethpage, New York.
Type: Two-seat carrier-based multi-role fighter.
Engines: Two 20,900lb (9,480kg) thrust P&W TF30-414 turbofans, (F-14D) two 29,000lb (13,150kg) thrust GE F110 turbofans.
Dimensions: Span (swept) 38ft 2½in (11·65m), (spread) 64ft 1½in (19·54m); length (A) 62ft 8in (19·1m), (D) 65ft 2in (19·86m); height 16ft (4·88m).
Weights: Empty 39,930lb (18,112kg); loaded (six AIM-54s) 69,790lb (31,656kg); max 74,348lb (33,724kg).
Performance: Max speed 1,584mph (2,549km/h, Mach 2·4) at 49,000ft (14,935m); 913mph (1,470km/h, Mach 1·2) at sea level; tactical radius on interdiction mission with drop tanks and Mk 82 bombs, 725 miles (1,167km);

combat air patrol 765 miles (1,232km); intercept mission 2,000 miles (3,200km); service ceiling over 50,000ft (15,240m).
Armament: One 20mm M61 Vulcan cannon with 675 rounds in fuselage; four AIM-7 Sparrow AAMs on lower edges of inlet ducts partially submerged, or four AIM-54A/C Phoenix AAMs on belly pallets, plus two wing pylons for one Phoenix or Sparrow and one Sidewinder or two Sidewinder; (attack role) various combinations of missiles and bombs up to 14,500lb (6,577kg).
History: First flight (A) 21 December 1970, (D) 14 July 1981; service entry 14 October 1972; first operational carrier deployment September 1974.
User: USN.

Below: For the fleet air defence role, Grumman designed the Tomcat to carry up to six of the big Phoenix long-range AAMs. With the internal M61A Vulcan cannon in the nose and the provision for one Sidewinder on each wing pylon for close-range combat, the F-14 is not a fighter to tangle with, as the Libyan Air Force discovered.

Development: To the Tomcat has gone the distinction of being the only US-operated fighter aircraft to achieve success in combat since the end of the South-East Asia conflict. The event was the ill-judged attempt by Libyan Arab Republic Air Force aircraft to penetrate the fighter screen around a US Sixth Fleet carrier battle group in the Gulf of Sirte in August 1981, and the result was the shooting down of two Sukhoi Su-22 Fitter fighter-bombers by F-14A Tomcats of VF-41 ("Black Aces") using AIM-9L Sidewinder missiles. Although the Libyans had operated the more potent MiG-25 Foxbat near the scene of the clash, they chose to attempt air-to-air combat using the lack-lustre Fitter, an almost suicidal mission when mixing it with F-14s.

At present there is only one service variant of the Tomcat in the US Navy, the F-14A, the higher-powered F-14B and improved F-14C having been abandoned. Initial deliveries of this large twin-engined, two-seat interceptor were made to VF-1 and VF-2 in October 1972, with carrier deployment taking place in September 1974. Despite its size, the Tomcat proved that it was more than capable of looking after itself in mock combat exercises against Phantoms and other aircraft.

The variable-sweep wings are computer-controlled and can move automatically between 20° and 68°; fully swept, they give the F-14 high-speed manoeuvrability in combat, and when fully extended they allow take-offs in less

than 1,000ft (300m) and landings in 2,000ft (600m) at low air speeds. To further improve its flying characteristics, the F-14 has small retractable glove vanes in the fixed leading edge of the wings (a unique feature of the design), and these normally deploy automatically above Mach 1.

The Tomcat's weapon system is built around the impressive AWG-9 radar and the Hughes AIM-54 Phoenix long-range air-to-air missile. With its 132lb (60kg) explosive warhead, capable of knocking down the largest of aircraft, the Phoenix has demonstrated its operational capability over more than 150 firings, destroying drones simulating a range of targets including Soviet Backfire bombers and Foxbat fighters at heights varying between 50ft (15m) and 80,000ft (24,400m), at speeds of up to Mach 2·8 and at ranges of more than 100 miles (160km). The radar/missile system is also capable of engaging up to six targets at the same time, and tests have shown an 80 per cent kill rate for this type of attack.

Tomcats fulfil the fighter-cover role for the majority of the US Navy's attack carriers, each ship normally having a complement of two 12-aircraft squadrons; the Midway class are unable to operate F-14s and are converting from F-4 Phantoms to F-18 Hornets. At sea the Tomcats normally operate in pairs under the control of an E-2C Hawkeye early warning aircraft and usually undertake any one of three types of mission: air cover for a task force (FORCAP); air cover for attack aircraft in enemy airspace (TARCAP); and barrier defence against retaliatory air attacks (BARCAP). Although each aircraft can carry up to six Phoenix missiles, the routine armament for most sorties consists of two examples each of the AIM-9 Sidewinder, AIM-7 Sparrow and AIM-54 Phoenix which, combined with the cannon, gives a potent warload for most situations. Two or three F-14As on each carrier can now carry TARPS (Tac- ▶

Above: An important element in carrier operations is the air refuelling tanker. A KA-6D of VF-355 aboard *Nimitz* pumps fuel into one of two Tomcats of VF-41 "Black Aces" complete in toned-down markings.

Left: It could be said that this aircraft of VF-101 "Grim Reapers" is taking the low-visibility orders far too literally. Even the old red danger markings are grey.

Below: The hot end of a Tomcat, showing the variable outlet nozzles and between them the unique beaver tail. The widely separated engine pods give extra keel area and contribute to directional stability.


NAVY

Above. A TARPS reconnaissance pod under an F-14A. An unusual aspect of this picture is the extended glove vanes which are seldom seen as they only appear at supersonic speed.

Left: An F-14A of VF-41 "Black Aces" makes a perfectly judged approach to land aboard *Nimitz* during Exercise "Teamwork 80" off Norway. Even at this angle the pilot still has good visibility over the nose.

tical Airborne Reconnaissance Pod System); a total of 49 aircraft have this capability, and replace the dedicated RA-5C Vigilante and RF-8G Crusader. The pod houses cameras for forward-oblique, panoramic or vertical shots and an infra-red scanner; it is located under the rear fuselage, and allows the full armament to be retained.

From 1989, the Navy will begin to receive examples of the F-14D, an improved version powered by what the Navy hopes will be a more reliable engine, the 29,000lb (13,150kg) thrust General Electric F110 turbofan. This engine was flight-tested in the seventh prototype Tomcat between July and September 1981, and showed significant performance improvements over the existing ▶

Above: Wings fully extended, flaps down, slats out and hook dangling, a Tomcat approaches the carrier flight deck at about 123kts (227km/h). On touchdown, the throttles are advanced to full military power in case the wires are missed and another circuit is called for.

Pratt & Whitney TF30. The F-14D "Super Tomcat" will have 2,000lb (907kg) more fuel in a 30in (760mm) fuselage extension, an AYK-14 central computer originally developed for the Hornet, a Honeywell laser-gyro inertial navigation system, programmable multi-function cockpit displays for both pilot and navigator, and a Joint Tactical Information Distribution System data link; in addition, the D will get the AIM-120 AMRAAM and the latest AIM-54C "digital" Phoenix missile. In tests the new engine has proven to have good throttle response, relatively low fuel consumption and an almost smokeless exhaust compared with the dirty trail left by the TF30.

Whilst the Tomcat programme has been by no means trouble-free, the Navy is confident that the aircraft will remain a viable air defence fighter well into the late 1990s, and production of more than 800 for some 24 squadrons is envisaged. In addition to training units at Miramar, California, and Oceana, Virginia, units equipped with F-14As include VF-1, VF-2, VF-11, VF-14, VF-21, VF-24, VF-31, VF-32, VF-41, VF-51, VF-74, VF-84, VF-103, VF-111, VF-114, VF-142, VF-143, VF-154, VF-211 and VF-213. The first Navy Reserve Squadron is VF-301 at Miramar, which received F-14As in October 1984, to be followed by VF-302 in 1985.

The only other operator of the Tomcat is the Iranian Islamic Revolutionary Air Force, which is thought to fly about twelve airworthy examples from an original procurement of 80 F-14As in 1976–78. Experts are doubtful that the sophisticated Phoenix missile system is still working on these aircraft, although, with judicious swapping of parts, the flyable aircraft may possibly be able to use their AWG-9 radars for long-range detection of Iraqi aircraft before the latter reach Iranian targets.

Below: Fighter Squadron VF-1 "Wolfpack" had the distinction of being one of the first units to commission with this big aircraft in 1972. Features in this view include the empty Phoenix pallets, ECM pod under the nose and the UHF/Tacan aerial behind the cockpit.

Hughes AH-64 Apache

AH-64A

Origin: Hughes Helicopters (division of McDonnell Douglas), Culver City.
Type: Anti-tank helicopter.
Engines: Two 1,695shp GE T700-701 free-turbine turboshafts.
Dimensions: Diameter of four-blade rotor 48ft (14·63m); length overall (rotors turning) 58ft 3in (17·76m); span of wings 17ft 2in (5·23m); height overall 16ft 9½in (3·84m); undercarriage track 6ft 8in (2·03m).
Weights: Empty 11,015lb (4,996kg); max loaded 17,650lb (8,006kg).
Performance: Max speed 13,925lb (6,316kg) 192mph (309km/h); max cruising speed 182mph (293km/h); max vertical climb 2,500ft/min (12·7m/sec); max range (internal fuel) 380 miles (611km); ferry range 1,121 miles (1,804km).
Armament: One Hughes M230A1 30mm Chain Gun with 1,200 rounds (Honeywell, Aden or DEFA ammunition) in collapsible ventral turret; four wing hardpoints for 16 AGM-114A Hellfire missiles or 76 2·75in (70mm) FFARs in four pods, or mix of these weapons.
History: First flight (YAH-64) 30 September 1975; service entry 1985.
User: US Army.

Above: One of the Apache prototypes firing a salvo of rockets. This weapon is designed for saturation fire and would more likely be used against "softer" targets than against heavy armour.

Below: The Apache was designed to present as small a frontal target as possible, and Hughes have managed this well.

Above: In a desert setting, a production AH-64A is posed for a Hughes photographer to record the standard types of weapon carried by this helicopter. On the ground are four ferry tanks, four 2.75in rocket pods, 75 FFAR rockets and 13 rows of 30mm rounds. The stub wings carry 16 AGM-114A Hellfire "fire-and-forget" anti-armour missiles. Under the nose and pointing straight at the camera is the powerful 30mm Chain Gun. The success or failure of an Apache mission depends on the advanced TADS/PNVS system, housed in the collection of shapes in the machine's nose.

Right: Like some menacing pre-historic bird, a production Apache thrashes by with a load of eight Hellfire missiles, but with outer pylons empty. Much of the fuselage and the more vulnerable parts such as the engines and avionics bays are protected by lightweight armour able to withstand gunfire up to 23mm calibre. This is probably the most expensive helicopter ever to enter production.

Development: The AH-64A Apache represents the current production "state of the art" in helicopter design. Its futuristic shape is no accident nor a designer's whim, but the result of extensive development to produce an attack helicopter for the US Army that can survive combat, is able to take full advantage of NOE (nap of the earth) flight in any weather, day or night, will give its crew the maximum protection possible, and can provide a hefty punch with missiles and guns against enemy tanks.

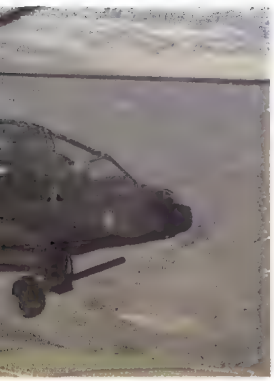
The basis of the Apache's attack capability is vested in a collection of boxes under the armoured fuselage skin and in the group of strange-looking lumps on the nose. This is the TADS/PNVS, or Target Acquisition and Designation System/Pilot Night Vision Sensor, produced by Martin-Marietta. TADS includes a low-light-level TV, a forward-looking IR (FLIR) sensor and direct-viewing telescope optics for acquiring the target. There is also a laser rangefinder and a laser target designator to guide the Hellfire anti-armour missiles which form the Apache's main armament. Information from the TADS/PNVS is displayed on the monocle of the Integrated Helmet and Display Sight System (IHADSS). This amazing device permits pilots to view data while watching the target, to point weapons at the target and to cue line-of-sight data between cockpits.

Beneath the front fuselage, in a flexible mounting, is a Hughes-developed 30mm cannon firing standard rounds or specially designed, shaped-charge, chemical-energy, armour-piercing shells. Vital parts of the Apache are protected by armour capable of withstanding hits by 23mm calibre rounds. The flat, non-glint cockpit canopy panels are also armoured, and the fuel tanks are self-sealing.

Noise is one of the helicopter's biggest problems, and Hughes engineers have managed to reduce this aspect on the Apache, not quite to "whisper mode" but ▶

certainly to less than that of the current AH-1S Cobra. Hot gases from the engines are dispersed via the company's Black Hole suppression system to reduce significantly the IR signature and protect the machine from heat-seeking SAMs. RWR and flare/chaff dispensers are also fitted for self-defence.

Apache production for the US Army is well under way to the planned 1986 figure of twelve machines per month, and the first unit will become operational during 1985. Deployment plans call for the basing of a large number of machines in Europe to help redress the balance between NATO and the Warsaw Pact tank forces. Despite its relatively high cost — $10·5 million per aircraft in 1984, which threatened to torpedo the whole programme some years ago — present procurement plans call for 675 Apaches to be built, with the entire fleet expected to



Left: At the rear of the engines in this view can be seen the Hughes-patented Black Hole IR heat suppression unit designed to reduce the threat posed by heat-seeking missiles. Although highly advanced, the Apache does not have a mast-mounted sight, which means that the pilot has to expose the complete machine above cover to use the TADS/PNVS equipment. This could prove a costly omission. The AH-64's complex and expensive avionics are complemented by an array of threat warning/decoy systems, including RWR, radar jammer, laser detector, infra-red jammer and chaff and flare equipment. The USMC is currently studying the possibility of acquiring a shipboard version of the Apache.

be in the field by 1990. Initial deliveries are being made to units at Fort Rucker, Fort Eustis and Fort Campbell, as well as to the Army's Proving Ground at Yuma, Arizona.

A shipboard version of the Apache is being studied by the US Marine Corps for both anti-armour and anti-ship use. In the latter role it would be fitted with Harpoon or Penguin anti-ship missiles or with rockets. Sidewinder armament would give a measure of protection, and the 30mm Hughes Chain Gun would be retained. Evaluation of this project continues.

Hughes executives forsee orders for well over 1,000 Apaches over the next few years although overseas customers could be deterred by the high cost involved and may prefer the Bell SuperCobra.

Left: FFARs leave the outer pods for a distant target during weapon trials. The Apache's engines are spaced as far apart as possible to stop the effect of enemy fire disabling both powerplants at the same time. An air data sensor mast is above the rotor hub.

Below: It has taken ten years to develop the AH-64A from first flight of the prototype in September 1975 to the delivery of full production machines in 1985. Five prototype vehicles were built plus a ground test airframe, and the current production rate at Hughes' Mesa, Arizona, facility is twelve helicopters a month.

Lockheed AC-130 Hercules

AC-130A, H

Origin: Lockheed-Georgia Company, Marietta, Georgia.
Type: Special armed gunship version of transport aircraft.
Engines: (AC-130H) Four 4,910ehp Allison T56-15 turboprops flat-rated at 4,508ehp.
Dimensions: Span 132ft 7in (40·14m); length 97ft 9in (29·79m); height 38ft 3in (11·7m).
Weights: Empty (basic H) 72,892lb (33,063kg); operating weight (H) 75,832lb (34,397kg); max overload 175,000lb (79,380kg).
Performance: Max speed at 175,000lb (79,380kg), also max cruising speed (H) 386mph (621km/h); economical cruise 345mph (556km/h); initial SL climb 1,900ft (579m)/min; service ceiling at 155,000lb (70,295kg), 26,500ft (8,075m); range with max payload 2,487 miles (4,002km); take-off to 50ft (15m) (H at 175,000lb, 79,380kg), 5,160ft (1,573m); landing from 50ft (H at 100,000lb, 45,360kg), 2,700ft (823m).
Armament: (A) Two 40mm, two 20mm Vulcan and two 7·62mm Miniguns; (H) one 105mm howitzer, two 20mm Vulcan and two 7·62mm Miniguns.
History: First flight (YC-130A) 23 August 1954, (production C-130A) 7 April 1955, (H) 30 November 1964; service delivery December 1956.
Users: MAC, AFRES.

Above: The armed AC-130A night gunship saw USAF service towards the end of the Vietnam War and was considered a major advance over the previously operated AC-47 and AC-119 gunships.

Below: "Puff the Magic Dragon" was an apt nickname for the fire-spitting gunships as they circled their targets pumping cannon rounds at a suspected guerrilla infiltration. This AC-130A is firing its port-side guns while in a steady bank.

Development: Finished in sombre coats of dark paint, the attack variants of the Lockheed C-130 Hercules transport combine endurance and firepower to provide effective support against all but the most determined enemy. The idea for such a heavy weapon evolved during the South-East Asia conflict when it became obvious that the night was the Viet Cong's biggest friend and that to deprive "Charlie" of darkness would significantly reduce his effectiveness. The first aircraft used for this type of night operation was the AC-47 Spooky, a modified Dakota transport with three miniguns firing out of the port side of the fuselage. Directed to an area where the enemy might be found, the slow AC-47 banked in a wide left-hand turn and poured a hail of fire into the target, sometimes with devastating results but more often with little tangible evidence to show the success of the sortie. However, it was one of the most spectacular weapons used during the war. The AC-119 version of the Boxcar transport was also used, and both types were later passed on to the South Vietnamese Air Force.

From these twin-engined gunships, there came the more imaginative AC-130. The first variant was the AC-130A, fitted with eight guns bolted along the port side of the fuselage – four 20mm Vulcan cannon and four 7·62mm Miniguns – plus cameras, flares and high-intensity lights for battlefield illumination. Ten of these aircraft remain in USAF service, their armament having been changed to two 40mm cannon, two 20mm Vulcan cannon and two 7·62mm Miniguns. They currently operate with the 711th Special Operations Sqn, Air Force Reserve, at Eglin AFB, Florida. The otherwise similar AC-130H differs in having a 105mm howitzer in place of one of the 40mm cannon and provision for in-flight refuelling. There are again ten of these in use, and they form part of the equipment of the 1st Special Operations Wing at Hurlburt Field, Florida, within the 23rd Air Force, MAC. To enhance the capability of both versions of the AC-130, the aircraft are fitted with sensors and target acquisition systems, including FLIR and low-light-level TV.

Above: An AC-130H gunship of the type that assisted US forces during the invasion of Grenada. The H version carries what is probably the largest calibre gun flying, a 105mm howitzer.

Below: The impressive fire from this gunship is put on target with the help of acquisition systems including FLIR and low-light-level TV. Fortunately the Hercules handles with surprising agility.

McDonnell Douglas A-4 Skyhawk

A-4E, F, L, M, Y; TA-4F, J; OA-4M

Origin: Douglas Aircraft (division of McDonnell Douglas), USA.
Type: Single-seat attack bomber, (OA) two-seat FAC aircraft, (TA) dual-control trainer.
Engine: (E) One 8,500lb (3,856kg) P&W J52-6 turbojet, (F) 9,300lb (4,218kg) J52-8A, (M, Y) 11,200lb (5,080kg) J52-408A.
Dimensions: Span 27ft 6in (8·38m); length (E, F, L) 40ft 1½in (12·22m), (M, Y) 40ft 3¼in (12·27m), (OA, TA, exc probe) 42ft 7¼in (12·98m); height 15ft (4·57m), (TA) 15ft 3in (4·65m).
Weights: Empty (E) 9,284lb (4,210kg), (Y) 10,465lb (4,747kg), (TA-4F) 10,602lb (4,809kg); max loaded (shipboard) 24,500lb (11,113kg), (land-based) 27,420lb (12,437kg).
Performance: Max speed, clean (E) 685mph (1,103km/h), (Y) 670mph (1,078km/h), (TA-4F) 675mph (1,087km/h); max speed, 4,000lb (1,814kg) bomb load (Y) 645mph (1,040km/h); initial climb (Y) 8,440ft (2,572m)/min; service ceiling (all, clean) about 49,000ft (14,935m); range (clean, or with 4,000lb (1,814kg) weapons and max fuel, all late versions) about 920 miles (1,480km); max range (Y) 2,055 miles (3,307km).
Armament: Standard on most versions, two 20mm Mk 12 cannon, each with 200 rounds; pylons under fuselage and wings for total ordnance load of (E, F, L) 8,200lb (3,720kg), (M, Y) 9,155lb (4,153kg).
History: First flight (XA4D-1) 22 June 1954; (A-4A) 14 August 1954; squadron delivery October 1956, (A-4M) April 1970, (A-4N) June 1972, first of TA series (TA-4E) June 1965, (OA) 1979.
Users: USN, USMC.

Development: Like old soldiers, the US Navy's A-4 Skyhawk force is just fading away, but its memory will never die. The aircraft's capabilities far exceeded its size, and a production run of 2,960 in some seventeen different configurations over 25 years are statistics which will constantly be repeated in connection with this remarkable design.

The brainchild of Douglas designer Ed Heinemann back in 1952, the Skyhawk was the outcome of a US Navy requirement for a carrier-based attack aircraft of 30,000lb (13,600kg) and powered by a turboprop engine. The Douglas team responded with a 12,000lb (5,440kg) tailed-delta jet bomber with a speed some 100mph (160km/h) faster than specified. Small enough not to need folding wings for carrier stowage, the Skyhawk was ordered by the more than surprised Navy and entered service with VA-62 in October 1956. "Heinemann's Hot Rod", "Bantam Bomber" and "Scooter" became affectionate terms for an aircraft that is easy to fly, maintain and repair.

Although production ended in February 1979, the A-4 remains in Navy Reserve and USMC service. It is no longer operated from the front-line carriers, and most of the Marine-operated single-seaters will be withdrawn when there are sufficient numbers of AV-8B Harrier IIs available. ▶

Above: The black ram's head on the intake trunk of this A-4M Skyhawk II identifies an aircraft of Marine Corps attack squadron VMA-214 "Blacksheep" of the 3rd Marine Air Wing, El Toro. The M version was perhaps the most attractive of all Skyhawk variants.

Left: An A-4N Skyhawk of Marine unit VMA-324 fires a pack of FFARs during weapon training. Marine Skyhawks are scheduled to be replaced by AV-8B Harrier IIs, but their combat capability is such that they are likely to find new operators in Third World countries looking for lightweight attack aircraft with a good performance and weapon-carrying capacity.

The A-4E is powered by an 8,500lb (3,855kg) Pratt & Whitney J52-P-6 engine. A total of 498 production Es were built following initial operational status in November 1962 with VA-23. Painted in toned-down grey colours, a number of aircraft fly with Navy units for air combat training, the Skyhawk being similar in performance to the Soviet MiG-17, and the Marines retain some Es in the reserve 4th Marine Air Wing.

The A-4F was the last major single-seat variant developed for the USN. The type has a large dorsal fairing covering additional avionics (hence the nickname "Camel"), a more powerful 9,300lb (4,220kg) J52 engine, and other modifications. The first of 146 entered service in June 1967. The A-4L is an A-4C updated to A-4F standard, and 100 were converted for Navy and Marine Reserve units. Most are now in storage.

The A-4M was specially developed for the Marines and 160 aircraft were produced. It has an 11,200lb (5,080kg) thrust J52, a larger canopy, more ammunition for the 20mm guns and a redesigned fin among a number of internal and external modifications. The principal Marine units flying the M are VMA-331, at Cherry Point; VMA-214, at Iwakuni, Japan; and VMA-211, VMA-223 and VMA-311, all at El Toro, California. The first USMC Reserve unit to operate Ms is VMA-322.

The TA-4F and J are two-seat models for advanced training. Initially 241 TA-4Fs were built, with deliveries beginning in May 1966 to VA-125 at Lemoore NAS. Most were subsequently converted to J standard, and a further 292 TA-4Js were produced as new-build aircraft. Both types currently equip Navy and Marine advanced and fleet training units. They are due to be replaced by the T-45 Hawk towards the end of this decade. The OA-4M is a specialised forward air control version of the Skyhawk. The Naval Air Rework Facility at Pensacola converted 23 TA-4Fs into OA-4Ms, and deliveries to Cherry Point NAS began in 1979. The principal users of the type are H&MS-13 "Outlaws" at El Toro and H&MS-32 at Cherry Point. The A-4Y is the USMC designation for A-4Ms retrofitted with the Hughes Angle Rate Bombing System, which improves bombing accuracy and gives first-pass acquisition capability. Further improvements include the addition of APR-43 and ALR-45F radar warning receivers and the ALQ-162 jammer.

Such is the versatility of this small combat aircraft that it is likely to be around for some years to come, certainly with the Marine Reserve forces if not with the Navy equivalent. It has proved itself in combat in South-East Asia with the air forces of Israel and Argentina, and by virtue of its simplicity, ruggedness and reliability it will continue to be operated by a number of air arms long after its withdrawal from US service.

Above. "Enemy" Skyhawks of the US Navy squadron VA-127 "Cylons", based at NAS Lemoore, a unit that operates in the "Aggressor" role to train front-line aircrew in the current tactics used by possible future opponents, in particular the USSR. These aircraft are TA-4Js painted in the present low-visibility grey colours with markings to match. In performance, the Skyhawk is similar to the Soviet "Fresco" (MiG-17) which still serves with a number of Eastern Bloc air arms.

Far left: The TA-4J is used by the Navy and Marines for advanced training. This example is seen landing with its rear airbrakes extended and wing slats out. Points of interest are the long refuelling boom, the externally braced rudder and the drop tanks on the inboard pylons. Instead of individual elevators, the A-4 was designed with an all-moving tailplane.

Left: A two-seat J from training squadron VT-125 about to go over the top. To accommodate the second seat, overall length was increased by nearly 2.5ft (76.2cm) and internal fuel reduced. Trainers have simplified avionics.

McDonnell Douglas F-4 Phantom II

F-4C, D, E, G, S; RF-4C

Origin: McDonnell Aircraft Company, St Louis, Missouri.
Type: (C, D, E) All-weather interceptor and attack aircraft, (G) EW platform, (RF) reconnaissance aircraft.
Engines: (C, D, RF) Two 17,000lb (7,711kg) thrust GE J79-15 afterburning turbojets. (E, G) two 17,900lb (8,120kg) J79-17.
Dimensions: Span 38ft 5in (11·7m); length (C, D) 58ft 3in (17·76m), (E, RF) 63ft (19·2m); wing area 530 sq ft (49·2m²).
Weights: Empty (C) about 28,000lb (12,700kg), (D) 28,190lb (12,787kg), (E) 30,328lb (13,757kg), (G) about 31,000lb (14,000kg), (RF) 29,300lb (13,288kg); max loaded (C, D, RF) 58,000lb (26,300kg), (E, G) 60,360lb (27,374kg).
Performance: Max speed (C, D, E, Sparrow AAMs only external load) 910mph (1,464km/h, Mach 1·19) at low level, 1,500mph (2,415km/h, Mach 2·27) over 35,000ft (10,670m); initial climb, low level (AAMs only external load) 28,000ft (8,534m)/min; service ceiling 60,000ft (18,290m) without external stores; range on internal fuel (no external weapons) typically 1,750 miles (2,817km), ferry range, clean except three tanks (C, D, RF) 2,300 miles (3,700km), (E, G) 2,660 miles (4,281km); take-off run (clean) 5,000ft (1,525m); landing run 3,000ft (914m).

Armament: (C, D) Up to 16,000lb (7,257kg) assorted stores on external pylons including four AIM-7 Sparrow AAMs recessed into underside of fuselage/wing junction and two more AIM-7, or four AIM-9 Sidewinder, on inboard pylons; (E) same plus 20mm M61A-1 gun under nose; (G) typically three AIM-7 Sparrow recessed, three Mavericks or one Standard ARM plus two AIM-9 on each inboard pylon, and one Shrike on each outboard pylon, plus any other ordnance carried by other versions; (RF) none.
History: First flight (F4H-1) 27 May 1958, (F-4C) 27 May 1963.
Users: TAC, PACAF, USAFE, ANG, AFRES, USN, USMC.

Development: The F-4 Phantom II will surely rank as one of the classic fighters of all time. With its upturned wingtips, anhedral tailplane and aggressively downturned nose, the design stood at the forefront of fighter development in the 1960s. The prototype F4H-1 made its first flight in US Navy colours in 1958 and eventually became the standard front-line fighter aircraft in all three US Services; it was also exported to ten overseas air forces. It has been estimated that of the 5,173 Phantoms built, some 1,500 will still be in use by the year 2000. As it was originally designed for carrier operations, it was to the US Navy that the first F4Hs – later designated F-4s – were delivered in December 1960; the initial production version, following 24 F-4As, was the F-4B, with 637 aircraft built, and 46 RF-4B reconnaissance versions were produced for the US Marine ▶

Below: The nose says it all – the 5,057th and last St Louis-built F-4, an E version for the USAF which departed the factory on Friday 26 October 1979. No 80744 was also the last of 2,874 Air Force Phantoms, comprising F-4Cs, Ds, RFs and Es.

Corps. In all, 1,218 F-4 fighters were delivered to the USN and USMC and at the peak of their service they equipped 65 squadrons.

In the US Air Force, the Phantom provided the ascendancy needed for air combat in Vietnam and today more than 1,600 F-4s equip USAF squadrons in TAC, PACAF and USAFE and in associated ANG and AFRES squadrons. The F-4C was the first USAF version; 583 were delivered, and a number still serve in Air National Guard and Air Force Reserve units. The F-4D looks externally similar to the B except that it has no IR sensor under the nose but incorporates system improvements in the form of weapons ranging and release computers to increase accuracy during the delivery of both air-to-air missiles and air-to-ground weapons. A total of 793 aircraft of this version were bought and most remain in service, again generally with ANG and Reserve units.

The Phantom was seen as an ideal platform for a multi-sensor reconnaissance system aimed at replacing the RF-101 Voodoo in the tactical role. Designated RF-4C, this sophisticated machine carries cameras in a lengthened nose, IR linescan, SLAR (side-looking airborne radar), a mapping radar, a flash/flare car-

tridge ejection system and ECM/HF equipment. Twenty-four aircraft are being given a TEREC (Tactical Electronic Reconnaissance) sensor for locating electronic emitters, while other improvements include the provision of Pave Tack to enhance target location by day or by night and a data link to relay SLAR and TEREC information immediately to battlefield commanders. The survivors of the 505 RF-4Cs built operate with six squadrons in Europe, the Pacific and the USA, plus a further six units in the ANG.

The F-4E was the result of Vietnam experience and incorporated an M61 gun under the nose, an extra fuel cell in the rear fuselage, a new APQ-120 solid-state radar at the front and more powerful J79 engines to cope with the increased weight. All Es were subsequently fitted with leading-edge slats to improve manoeuvrability in combat, and some have received TISEO (Target-Identification System Electro-Optical) equipment to aid visual identification of targets at long-range (the system is located on the leading edge of the port wing). Pave Tack and Pave Spike are additional improvements: the former is an all-weather, day or night target designator for IR, laser or EO-guided weapons, whilst the latter is a laser designator pod for daylight use with "smart" weapons. As the Es are replaced by F-15s and F-16s, they in turn will replace older F-4Cs and Ds in the ANG. In all, the USAF received 949 F-4Es.

During the Vietnam War, Wild Weasel was a name synonymous with the SAM-suppression F-105 Thunderchiefs. Their successors are the F-4G Advanced Wild Weasels, the most expensive of all the Phantom variants. Located in and around a standard F-4E airframe are no fewer than 52 aerials designed to detect, identify and locate enemy radars. The main external features of the G are the pods facing forward under the nose and to the rear at the top of the fin. ▶

Above: Two "Wolf Pack" F-4Ds of the USAF 8th TFW in Vietnam-style camouflage. Note the ventral hump on the chin-mounted IR sensor of the nearest aircraft, which also has the "towel-rack" antenna for AN/ARN-92 LORAN navigation equipment.

Left: An RF-4C of the 10th TRW, RAF Alconbury, moments from touch-down. This recce variant is 4ft 8in (144cm) longer to accommodate the cameras and extra radar gear.

Below: A US Marine F-4J landing aboard USS *Nimitz*. This aircraft has been modified to F-4S standard.

Below: A wide-angle view of a 563rd TFS F-4G from George AFB, armed with an AGM-78 ARM under the starboard wing and a Maverick under the port wing. The undernose gun on this ex-F-4E has been replaced by a radar pod and similar equipment is housed in the fin-tip fairing. On the side of the nose is a heat exchanger ram air intake and behind that is one of the three night formation strips along each side of the aircraft. F-4G operations involve various tactics, including flying in pairs with one aircraft drawing the attention of the enemy while the second attacks the SAM site from behind.

Left: The 37th TFW at George AFB, California, is one of the specialised operators of the F-4G Wild Weasel. This aircraft is carrying only three drop tanks instead of the more usual anti-radiation missiles. The antennas in the fin-top and undernose fairings are only two items in the complex APR-38 radar detection and homing system — a system governed by a central computer with reprogrammable software to keep up to date on all known hostile emitters. Each F-4G has 52 special aerials.

Although it has no in-built gun, the G can carry a range of external weapons, including the AGM-78 Standard ARM, AGM-88 HARM, AGM-45 Shrike and electro-optical AGM-65 Maverick. For self-protection, three AIM-7 Sparrows are retained semi-recessed under the fuselage, the fourth missile station taking an ALQ-199 ECM pod. The F-4G entered service with the 35th TFW at George AFB, California, in October 1978 and now also operates with the 37th TFW at George, the 3rd TFW at Clark AB in the Philippines and the 52nd TFW at Spangdahlem, West Germany. All 116 Gs are expected to receive regular system updates, including the new Precision Location Strike System (PLSS). ▶

Above: Navy F-4S Phantoms prepare for launch from USS *Constellation* in October 1983. All wear low-visibility markings, and the nearest machine has a radar warning receiver fairing on the engine intake.

Right: Reluctant to ignore such a good airframe, Boeing and Pratt & Whitney have proposed this Super Phantom powered by two 20,000lb (9,072kg) thrust PW1120 engines, upgraded avionics (including the F-16's APG-66 radar) and a belly conformal fuel tank.

Above: Taken in July 1984, this view shows a Hawaii ANG F-4C Phantom in a low-visibility scheme designated "Egypt 1" and incorporating two national insignia markings on the fuselage. The USAF received 583 of the C version, of which 40 were transferred to Spain. Steadily diminishing numbers of F-4Cs still operate with the Air Guard.

The F-4J for the USN and Marine Corps was a much improved F-4B with better radar, more powerful engines and greater fuel capacity. Of the 522 delivered, 302 received further improvements under the designation F-4S, while 228 Bs were modified up to F-4N standard.

With the Phantom due to remain in US service until the end of the 1990s, further modifications to existing aircraft are inevitable. One of the most likely projects is the so-called "Super Phantom", a joint proposal by Boeing and Pratt & Whitney which involves changes to the airframe, powerplant and avionics. The most obvious external change would involve the additon of a 1,120gal (5,090l) conformal fuel tank under the fuselage, which would both extend the aircraft's range and provide more fuel for the larger PW1120 engines. At the behest of the USAF Aeronautical Systems Division at Wright-Patterson AFB, a demonstration Super Phantom is to be built to test the feasibility of the project prior to any major programme go-ahead. With the Air National Guard likely to have about 900 F-4s still in service around the year 2000, this element of the Air Force is keeping a close eye on progress.

McDonnell Douglas AV-8B Harrier II

AV-8B

Origin: McDonnell Douglas Corporation, St Louis, Missouri/British Aerospace, Kingston-upon-Thames, Surrey.
Type: Single-seat V/STOL light attack aircraft.
Engine: One 21,180lb (9,605kg) thrust Rolls-Royce Pegasus 11 turbofan.
Dimensions: Span 30ft 3½in (9·23m); length 46ft 3½in (14·1m); height 11ft 4in (3·5m); wing area 230 sq ft (21·3m²).
Weights: Empty operating 13,000lb (5,897kg); max take-off 29,750lb (13,495kg); max VTO (SL) 19,185lb (8,702kg).
Performance: Max speed (SL) 580kt (1,074km/h); typical radius (seven bombs, hi-lo-hi) 600nm (1,110km); ferry range (four tanks) 2,500nm (4,630km).
Armament: One 25mm GAU-12/U five-barrel Gatling-type cannon with 300 rounds in port pod; six underwing weapons pylons and one underfuselage position for total of 9,200lb (4,175kg) of air-to-ground guided and unguided ordnance; pylon loadings 2,000lb (907kg) inboard, 1,000lb (454kg) fuselage and intermediate wing positions, 630lb (286kg) outboard.
History: First flight (YAV-8B) 9 November 1978, (FSD AV-8B) 5 November 1981; service entry 1983.
User: USMC.

Above: Sixteen GP iron bombs give a good indication of the carrying capacity of the new AV-8B for the Marine Corps. The aircraft has been ordered as a close-support machine capable of flying relatively short-hop missions to aid the ground troops.

Below: One of the four AV-8B prototypes shown in a mock-up camouflaged revetment. The nose probe is not fitted to production Harrier IIs. Under the fuselage are the cushion augmentation strakes which are interchangeable with the 25mm GAU-12 cannon pod and its associated ammunition pod.

Development: Since it first received the AV-8A Harrier, the US Marine Corps has consistently championed the cause of VTOL aircraft for the support of ground forces. Therefore, despite the relatively high attrition rate of the early aircraft, it came as no great surprise when the Corps announced its intention to order the much-developed AV-8B Harrier II. Preliminary studies were made in the mid-1970s, and the prototype YAV-8B made its first flight from St Louis in November 1978. The prime contractor for the project is McDonnell Douglas, who forged a partnership with British Aerospace back in 1969 which has also seen the recent development and selection of the BAe Hawk (T-45) advanced trainer for the US Navy.

Superficially similar to the AV-8A, the Harrier II "Marine Machine" is a technically more advanced design and, in the close-support role for which it is intended, it has demonstrated a payload/range capability over 100 per cent better than the earlier aircraft. This is all the more remarkable when it is realised that the basic engine power remains as before. The reason is a combination of factors, but principally that weight has been reduced by the extensive use of composite materials without sacrificing strength. Areas where graphite/epoxy has been used include the forward fuselage, wing, flaps, rudder, fairings and doors, adding up to 26 per cent of the total weight for a saving of 480lb (218kg).

Aerodynamically, the B has a larger, supercritical wing with improved lift devices and leading-edge root extensions for increased manoeuvrability. The bigger wing gives more fuel space, putting overall capacity up by 50 per cent. A more efficient air intake design has been incorporated and better airflow characteristics around the wing have been achieved by altering the vectored thrust nozzles and their position relative to the wing. ▶

Above: Taken in November 1981, this view shows one of the Harrier II development aircraft on the ground with an earlier AV-8C hovering behind. The larger canopy and bigger wing of the new design are noticeable differences between the two types. Note that the leading edge root extensions have yet to be fitted to the AV-8B. Both the AV-8C and the A-4 Skyhawk will be replaced by the Harrier II as deliveries increase.

Left: This direct plan view of a development AV-8B shows a number of points to advantage, particularly the outrigger undercarriage locations inboard of the tips and the six underwing weapons pylons which, with the centreline station, can carry a maximum load of 9,200lb (4,173kg). The marking on the top of the canopy is an explosive cord which shatters the canopy prior to the pilot making an ejection.

Above: The third development aircraft conducting weapon release trials from Patuxent River in October 1982; these are Snakeye retarded bombs. Delivery accuracy has been consistently good.

Left: US Marine Harrier IIs will spend much of their time at sea, while their RAF GR.5 equivalents will operate from central European bases. The first GR.5 was due to fly in April 1985.

The pilot has a better view from the raised cockpit and blown canopy, and an all-new avionics suite reduces the pilot's workload and allows for more accurate weapons delivery. The Harrier II is also the first production combat jet to be equipped with fibre optics communications in place of copper/electrical conductors, the advantages being that optics are immune to electromagnetic interference and proof against external jamming.

The USMC plans to order 328 Harrier IIs, of which 28 will be two-seat TAV-8B trainers. The first of twelve pilot-production AV-8Bs was delivered to VMAT-203 Training Sqn at Cherry Point NAS, North Carolina, in January 1984, and 21 series production aircraft are due in 1985 for initial service use with the first front-line unit. The type will replace five squadrons of USMC A-4 Skyhawk attack aircraft and three squadrons of AV-8As, and it is expected that production will continue into the early 1990s.

On Marine operations, the AV-8B will undertake missions similar to those flown by the present AV-8As. The flexibility of V/STOL means that the aircraft can fly from large or small ships in support of amphibious landings, transferring to secure forward sites ashore for shorter-range strikes against enemy positions. If caught by enemy fighters, the Harrier II can defend itself with AIM-9 Sidewinder missiles and its single 25mm cannon, but "viffing" is its one big advantage over conventional aircraft. Using VIFF (Vectoring In Forward Flight), the Harrier pilot can decelerate quickly to force an enemy to overshoot, making him vulnerable to attack from an unexpected quarter.

The Harrier II is also on order for the Royal Air Force as the Harrier GR.5. An initial batch of 62 aircraft will be delivered from 1986, and the aircraft will differ from the Marine version in having a moving map display in the cockpit, two additional underwing weapon pylons ahead of the outrigger wheels, a radar warning receiver and a Martin-Baker ejection seat. Although slower than the present RAF GR.3, the Mk 5 will have nearly double the payload/range, giving it greater flexibility from Central European bases. The Spanish Navy has also contracted for twelve EAV-8Bs for carrier use.

The future development of the AV-8B was assured when, on 1 November 1984, the US Navy awarded McDonnell Douglas a $2·1 million design definition contract for a night attack version of the aircraft. Changes being considered for this version include a FLIR system, night vision goggles for the pilot and modifications to the cockpit lighting. With a programme go-ahead, the first night attack Harrier II could be flying in late 1986, deliveries following in 1989.

McDonnell Douglas F-15 Eagle

F-15A, B, C, D, E

Origin: McDonnell Aircraft Company, St Louis, Missouri.
Type: Air-superiority fighter with secondary attack role.
Engines: Two 23,930lb (10,855kg) thrust P&W F100-100 afterburning turbofans.
Dimensions: Span 42ft 9¾in (13·05m); length 63ft 9in (19·43m); wing area 608 sq ft (56·5m²).
Weights: Empty (basic equipped) 28,000lb (12,700kg); loaded (interception mission, max internal fuel plus four AIM-7, F-15A) 41,500lb (18,824kg), (C) 44,500lb (20,185kg); max with max external load (A) 56,500lb (25,628kg), (C) 68,000lb (30,845kg).
Performance: Max speed (over 36,000ft, 10,973m, with no external load except four AIM-7), 1,653mph (2,660km/h, Mach 2·5); with max external load or at low level, not published; initial climb (clean) over 50,000ft (15,240m)/min, (max wt) 29,000ft (8,840m)/min; service ceiling 65,000ft (19,810m); take-off run (clean) 900ft (274m); landing run (clean, without brake chute) 2,500ft (762m); ferry range (three external tanks) over 2,878 miles (4,631km), (with FAST packs also) over 3,450 miles (5,560km).
Armament: One 20mm M61A-1 gun with 940 rounds; four AIM-7F (later AMRAAM) fitting against fuselage, four AIM-9L (later ASRAAM) on flanks of wing pylons; total additional ordnance load 16,000lb (7,257kg) on five stations (two each wing, one centreline).
History: First flight (A) 27 July 1972, (B) 7 July 1973; service delivery (Cat II test) March 1974, (inventory) November 1974.
Users: TAC, PACAF, USAFE, ANG. ▶

Above right: Nose-on, an F-15 displays the so-called "nodding" engine intakes which move up or down to maintain the optimum rate of airflow to the engines and thus obtain the necessary efficiency for the various flight regimes.

Right: An F-15A of the 33rd TFW, based at Eglin AFB, Florida. This view emphasises the various major components that form the design, the two long intake/engine trunks, front fuselage, wings, tailplanes and fins. Under the fuselage is a 600gal (2,270l) fuel tank.

Below: A formation take-off by two F-15As of ADTAC's Langley-based 48th FIS. The fin-tip fairings on each aircraft are radar warning (port) and electronic countermeasures (starboard). By January 1985, more than 870 Eagles had been delivered to the USAF, Israel, Japan and Saudi Arabia.

Right: Despite its dedicated air superiority role with the USAF, MCAIR were promoting the Eagle's dual mission capability as early as 1976 when this photograph was taken. F-15B 71-0291 carries 18 500lb (227kg) Mk 82 slicks and four AIM-7 Sparrow AAMs. This aircraft was later developed into the Strike Eagle which was selected in February 1984 as the USAF's dual role fighter, designated F-15E.

Below: A two-seat F-15B from Nellis AFB's 57th TTW. The fuselage is the same length as that of the single-seat aircraft, but the canopy is modified to provide extra headroom for the second crewman. As the equipment fit remains almost identical for both versions, the two-seater can be operated in the air defence role as well as for training. F-15Cs and Ds have improved fuel capacity.

Development: Now in its second decade of service with the US Air Force, the McDonnell Douglas F-15 Eagle is also into its second major development programme, which involves its adaptation from an air-superiority fighter with a secondary attack role to an all-weather interdictor and strike aircraft. With the production lines at St Louis now completing the original USAF order for 729 airframes — currently F-15C single-seaters and F-15D two-seaters — the final drawings are in hand to switch production to the new F-15E model. This was the successful candidate in the USAF's competition for a dual-role combat aircraft, being selected over the GD F-16E in March 1984.

Carrying the company name Strike Eagle, the F-15E will begin to reach USAF units in 1988 when the first of 392 aircraft will be delivered. A two-man crew will share the work-load on this advanced aircraft. At the front, the pilot will have a wide-angle HUD in front of him, presenting navigation data from a forward-looking infra-red sensor, while the GIB (''Guy in the back'') will have head-down CRTs for radar, FLIR, digital map and threat warning displays. Some of this information will be fed into the cockpits from the LANTIRN low-altitude night/nav attack pod system which is carried under the aircraft's fuselage.

Cleverly designed conformal fuel tanks, known as FAST packs, provide an additional 8,820lb (4,000kg) of fuel and will enable the F-15E to carry up to 24,250lb (11,000kg) of ordnance on a series of underwing pylons and fuselage stations, a weapon load comparable to that of the F-111. Saturation bombing in bad weather by numbers of F-15Es is a real possibility given that each aircraft could carry up huge quantities of iron bombs; however, more advanced weapons such as laser-guided bombs, area-denial ordnance and anti-radiation ▶

weapons are more likely candidates. Using an internally mounted 20mm multi-barrel cannon in the wing root and the new AIM-120 AMRAAM air-to-air missile currently under development, the F-15E will retain full air combat capability. In fact the new aircraft will have an 87 per cent commonality of spares with the existing F-15s. But that Eagle is still only a fledgeling. What of the present operational bird?

Since its inception as the FX requirement in the mid-1960s, its selection by the USAF in 1969 and its entry into service in November 1974, the Eagle has retained its superiority as a Mach 2·5 long-range interceptor in the West's

Right: Based at Bitburg, West Germany, the 36th TFW comprises three squadrons equipped with F-15C (shown) and D models.

Below: An Eagle's talons: alongside the intake, the aperture for the internal 20mm Vulcan cannon; a short-range Sidewinder; and under the fuselage a Sparrow medium-range AAM. Red safety tags await removal.

gallery of aerial weapons. From June 1979, the initial F-15A single-seat aircraft and F-15B two-seat combat-capable trainer were succeeded in production and service by the F-15C and D respectively. These have 2,000lb (907kg) of additional internal fuel and can carry the conformal FAST packs containing 9,750lb (4,422kg) of fuel or an assortment of sensors (FLIR, laser designator, cameras, etc.) or a mix of fuel and sensors. To increase further the value of these later variants, they are fitted with a Hughes APG-63 lightweight X-band pulse-Doppler radar with a reprogrammable signal processor. In a combat situation, this advanced system enables the crew to switch instantly from one locked-on target to another, to switch from air to ground targets, and to go to a high-resolution mode giving the ability to pick one target from a tight formation even at maximum radar range.

The versatility of these later Eagles made them prime candidates to replace the long-serving F-106 Delta Darts in the Air Defence-TAC units in the continental United States. By the end of 1984, the 48th FIS at Langley and the 318th FIS at McChord had re-equipped. Part of the F-15 unit's role at these bases will be ▶

Below: Vought ASAT (anti-satellite) missile under a Space Command Eagle for vibro-acoustic trials as part of the captive test programme. In service the aircraft will zoom climb to launch the weapon at about 80,000ft (24,400m). Service introduction is set for 1987.

an anti-satellite mission, using the Air-Launched Miniature Vehicle (ALMV) being developed by a consortium of companies headed by Boeing, Hughes, Vought and Singer-Kearfott; this weapon is expected to become operational in 1987. A third ADTAC squadron, the 5th FIS at Minot AFB, re-equipped late in 1984, whilst the first Air National Guard unit to receive Eagles will be the 159th TFG at New Orleans in 1985.

However, it is Tactical Air Command which is the largest user of the F-15. By 1984 no fewer than seventeen TAC squadrons were operational with the type in the USA, with another seven units overseas. At the time of writing, no USAF F-15 has been used in combat, but in the hands of Israeli pilots the aircraft was "blooded" in 1983 over the Bekaa Valley against Syrian MiGs (the best that Soviet factories could produce) and scored more than 50 kills in big dog-fights for no loss – an amazing performance, unsurpassed in recent combat history. Saudi Arabia contracted for 60 Eagles and these are serving with three squadrons. In 1984 a handful of these aircraft clashed briefly with Iranian Phantoms, shooting down one of the intruding F-4s, again for no loss. The other overseas operator is the Japanese Air Self-Defence Force, which is buying 100 from a home production line set up by Mitsubishi.

Keeping such an advanced aircraft in the air and ready for any emergencies is a full-time task for the hard-worked ground crews, and the Eagle has come in for its share of criticism, being labelled at one time a "hangar queen" for spending much of its time on the ground on account of maintenance problems. In its early days, teething troubles with the engines and the systems were the cause of much concern, but today the Eagle has overcome most of its problems. Its accident rate, too, has now been reduced to 4·2 aircraft per 100,000 hours, making it

the safest air superiority fighter the USAF has ever operated. Between 1974 and 1983, 34 single-seat and three two-seat Eagles were destroyed in air and ground mishaps.

Whether the quadrupled fatigue life of the Eagle over that of the F-4 Phantom will see it survive longer in service is currently unknown, but the use of titanium in the high-stress areas for strength and of boron epoxy composites in the tails and elevators to reduce weight has resulted in a durable structure well able to stand the heavy demands of aerial combat. McDonnell Douglas claims that the aircraft is able to lose one of the vertical tails and three of the four wing spars and still survive to return to base.

Looking further into the future, the Air Force is funding an advanced technology version of the Eagle having short take-off and landing and higher manoeuvring capabilities. Fitted with movable canard surfaces and thrust directing engine nozzles, the demonstrator is scheduled to fly by 1988. The new design will enable the F-15 to operate from runways shortened by enemy attack with as little as 1,000ft 6305m) of usable surface.

Below: F-15E Strike Eagle demonstrates its ability to carry a heavy load of Mk 20 Rockeye cluster bombs plus four Sidewinders during its development phase in 1981. This is aircraft 71-0291 illustrated on page 112, but wearing a tactical camouflage. It was subsequently redesignated the Advanced Fighter Capability Demonstrator and fitted with a specially equipped rear cockpit for the second crew member to manage the increased number of avionics systems. The F-15E ensures Eagle production until well into the 1990s.

McDonnell Douglas F/A-18 Hornet

F/A-18A; TF-18A; RF-18A.

Origin: McDonnell Douglas Corporation, St Louis, Missouri.
Type: Single- and two-seat multi-mission strike fighter.
Engines: Two 16,000lb (7,257kg) thrust GE F404-400 augmented turbofans.
Dimensions: Span (over wingtip missiles) 40ft 5in (12·31m), (folded) 27ft 6in (8·38m); length 56ft (17·07m); height 15ft 4in (4·67m); wing area 400 sq ft (37·16m²).
Weights: Take-off (fighter mission) 34,700lb (15,740kg), (attack mission) 49,200lb (22,317kg).
Performance: Max speed at altitude about 1,188mph (1,915km/h, Mach 1·8); min carrier landing speed 131kt (242km/h); service ceiling 50,000ft (15·24km); combat radius 425nm (787km); ferry range 2,000nm (3,700km).
Armament: One M61 multi-barrel 20mm cannon in nose, 540 rounds; max external ordnance load up to 17,000lb (7,710kg) on nine stations including wingtips for Sidewinder AA missiles; centreline position for bombs or tanks, two on fuselage for AIM-7, tanks, FLIR pod or laser-spot tracker, inboard wing for ASMs (Harpoon or other stores), outboard wing for AIM-7 or other guided AAMs.
History: First flight 18 November 1978, (RF-18) 16 August 1984; USN/USMC service entry (F/A-18) 7 January 1983.
Users: USN, USMC.

Right: Hornets of VX-5 "Vampires", home-based at NAS Point Mugu, conducting carrier trials aboard USS *Constellation* prior to service introduction. The aircraft have no external weapons, carrying only underwing tanks.

Below: The F/A-18 is the current "state-of-the-art" in production jet combat aircraft, so much so that the new Soviet fighters "Fulcrum" and "Flanker" borrow design features from both this and the F-15.

Development: If nothing else, the F/A-18 Hornet can be considered a "survivor" — not from wartime combat, but from a lobby of antagonists in Congress and in the services who have levelled strong criticism at the aircraft over a variety of points ranging from cost overruns to performance shortfalls. The Hornet has indeed had its share of technical problems, which have prompted changes and modifications, but the basic design has weathered a stormy passage from first flight to service introduction, and in 1985 the programme appears to be secure.

The origins of the Hornet go back to the early 1970s and the Northrop YF-17 programme. A navalised version was submitted to the US Navy in 1974 in response to a VFAX requirement for a lightweight multi-mission fighter. In refined form the Navy ordered the design and it was agreed that McDonnell Douglas should take over the programme as they had more experience in building naval aircraft.

Production of the F/A-18 was centred on McDonnell's plant at St Louis, with General Electric supplying the smokeless F404 turbofan engines, Hughes the advanced APG-65 long-range look-up/look-down radar, and Northrop providing major portions of the airframe as the principal subcontractor.

Following the first flight of the prototype Hornet, an exhaustive test programme showed up a number of design problems with the aircraft. Modifications involved a redesign of the wing and lateral control surfaces to improve the roll rate at high subsonic speeds and reduce drag, a slight re-shaping of the horizontal stabilisers, and changes to the LEX (leading edge extensions) along the fuselage. As if these problems were not enough, early service experience revealed a weakness in the vertical tails produced by unanticipated stress from high angles of attack. At company expense, aluminium reinforcement of the affected area was made on existing aircraft and introduced on the production extremely busy line at MCAIR, St. Louis.

Left: Unburdened by external stores, a Hornet of VMFA-323 "Death Rattlers" leaves the deck of *Coral Sea* without the need of afterburner power. Lightweight, strong, fatigue- and corrosion-resistant graphite/epoxy material is used on the tailplane, fin and trailing edge flap skins; much of the fuselage is aluminium.

Below: A Sidewinder leaves the wingtip rail of a VMFA-314 "Black Knights" Hornet. This unit was the first to become operational and joined the USS *Coral Sea* in March 1984. At least 40 USN and USMC squadrons are planned to receive the aircraft although mission requirements could change this.

With replacement of the Navy and Marine F-4s being the most urgent requirement, the Hornet was cleared for the fighter mission by the Naval Air Test Center at Patuxent River by the end of 1981. Clearance for the attack role, however, was withheld after problems were found during trials by the Navy operational evaluation unit in 1982. Much of the criticism centred around the Hornet's ability to fly attack profiles within its specified 550nm (926km) range with a warload of four 1,000lb (454kg) bombs, FLIR and laser pods and two AIM-9 Sidewinders. Fuel capacity at maximum landing weight was also said to be "modest", a claim contested by the manufacturer and not supported by the acceptable figures produced during company trials.

On the other hand, the Marines found the Hornet to be just what they wanted to replace the A-7E Corsair. Marine Air Group 11 at El Toro, California, began initial evaluation early in 1983 and produced encouraging combat performance data which showed that, far from being inferior to the A-7 as some ▶

had said, the Hornet was much better in most flight regimes than the older aircraft. The pilots found the Hornet to be a superb flying and fighting machine, well able to look after itself in a target area.

The attack role is now being flown by Navy and Marine Corps squadrons using standard production Hornets, and by the end of 1984 the aircraft had chalked up more than 80,000 flight hours and had demonstrated a reliability two or three times better than current fleet aircraft. Confidence in the design was demonstrated when Canada announced that it had selected the Hornet to replace its CF-101 Voodoos and CF-104 Starfighters, 138 aircraft being contracted for; Australia followed, with 75, and Spain, with 72 plus an option for twelve more.

To train Navy and USMC aircrew on the F/A-18, VFA-125 was established at Lemoore NAS, the first deliveries of F-18As and TF-18As being made in 1981. Flying aircraft marked with Navy insignia on one side and Marines on the other, VFA-125 trained pilots for VMFA-314 (the Marines' oldest fighter

Below: An elliptical-section drop tank being fitted to a Hornet of VFA-125 "Rough Raiders" at a shore base. The central aperture on the nose is the muzzle of the M61 Vulcan cannon: the position gives good line-of-sight for the pilot when firing.

squadron) and -323, both home-based at El Toro and initially assigned to the carrier *Coral Sea,* and VMFA-531, also at El Toro. The first Navy unit was VFA-113, which relinquished its A-7Es in mid-1983 and operated as part of CVW-14 aboard *Constellation.* Two more Navy units are VFA-136 and -137, which are currently serving aboard *Coral Sea* with the two Marine units. In line with new policies whereby the reserves should not just receive less modern hand-me-downs from the active forces, the first Navy Reserve squadron – VFA-303 – is training with VFA-125 prior to getting its own Hornets in 1986; VFA-305 will follow in 1987. The Replacement Training Squadron for the Atlantic Fleet is VFA-106, established at Cecil Field, Florida, in 1984 and due to receive some 60 Hornets when fully operational.

Below: The two-seat TF-18 has a long canopy and full weapons capability.

Right: In the configuration shown — four Mk 84 1,000lb (454kg) bombs, three drop tanks and two Sidewinders — this Hornet flew a simulated attack mission 620nm (1,150km) from Patuxent River in September 1981.

Below: A "diamond nine" formed by Hornets of the two test squadrons, VX-4 from Point Mugu and VX-5 from China Lake. The setting is the Mojave Desert.

With ever-increasing numbers of F/A-18s now entering service, the Navy is evaluating various Carrier Air Wing compositions, although most carriers are scheduled to gain two fighter/attack squadrons in place of the A-7E squadrons. *John F Kennedy*, for example, has two F-14A Tomcat units and two A-6E Intruder units with no light attack aircraft, whilst *Coral Sea* will try to see if four F/A-18 squadrons and one A-6E squadron is a viable mix.

On 16 August 1984 the prototype RF-18 reconnaissance Hornet made its initial flight. Developed under a US Navy contract, this version has a sensor pallet carrying panoramic cameras and an infrared linescanner in place of the nose-mounted 20mm cannon. The USN has stated a requirement for 100–120 RF-18s as the long-awaited replacement for the withdrawn RF-8 Crusader (the sole operator of which is VFP-206). Among a number of improvements planned for the Hornet is a conformal dorsal fuel tank which would increase fuel load by 3,000lb (1,360kg); its development is being funded by McDonnell Douglas.

Left: The long open canopy identifies a TF-18 combat trainer loaded for the attack role with two low-drag bombs on each outboard wing pylon and three external fuel tanks. The drooped ailerons are used to increase lift during the approach to landing.

Northrop F-5

F-5E Tiger II, F-5F

Origin: Northrop Corporation, Hawthorne, California.
Type: Light tactical fighter aircraft.
Engines: Two 5,000lb (2,270kg) thrust GE J85-21A afterburning turbojets.
Dimensions: Span 26ft 8in (8·13m), (over AAMs) 27ft 11in (8·53m); length (E) 48ft 2in (14·68m), (F) 51ft 7in (15·72m); wing area 186 sq ft (17·3m²).
Weights: Empty (E) 9,683lb (4,392kg), (F) 10,567lb (4,793kg); max loaded (E) 24,676lb (11,193kg), (F) 25,225lb (11,442kg).
Performance: Max speed at 36,000ft (10,970m), (E) 1,077mph (1,734km/h, Mach 1·63), (F) 1,011mph (1,628km/h, Mach 1·53); typical cruising speed 562mph (904km/h, Mach 0·85); initial climb (E) 34,500ft (10,516m)/min, (F) 32,890ft (1,025m)/min; service ceiling about 51,000ft (15,550m); combat radius with max weapon load and allowances, (E, lo-lo-lo) 138 miles (222km); range with max fuel (E, all hi, tanks dropped, with reserves) 1,779 miles (2,863km).
Armament: Very wide range of ordnance to total of 7,000lb (3,175kg) not including two (F-5F one) M-39A2 guns each with 280 rounds and two AIM-9 missiles on tip rails.
History: First flight (N-156C) 30 July 1959, (production F-5A) October 1963, (F-5E) 11 August 1972, (F-20) August 1982.
Users: TAC, USAFE, PACAF, USN.

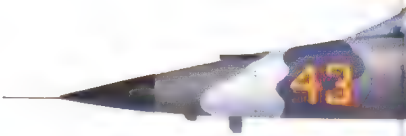
Development: There are over 1,300 F-5E single-seat fighters and F-5F two-seat trainers in service with twenty different air forces, and in many cases the type forms its country's main air defence interceptor. However, the USAF and US Navy rely on the design only for combat-training their fast-jet, front-line aircrew. The F-5E is an improved development of the original F-5A which was designed as an inexpensive lightweight tactical fighter. An uprated pair of J85 engines producing 5,000lb (2,270kg) of thrust, a modified wing giving better combat manoeuvring capability and wingtip-mounted AIM-9 Sidewinder missiles made the E a much sought-after weapon by many nations friendly to the USA, particularly those eligible to receive American military aid. In some air arms the type replaced such well-proven aircraft as the Hunter and Sabre; pilots found the E uncomplicated to fly, and ground-crews liked the easy-maintenance aspects of the airframe.

The first of 20 F-5Es was delivered to TAC in April 1973 to train foreign pilots and technicians, and the total USAF order eventually rose to 112 Es and Fs, the majority for dissimilar air combat training and better known as "Aggressor" aircraft. Because of its similar dog-fight capability to the Soviet MiG-21, the F-5E was adapted to train US pilots in Warsaw Pact fighter tactics under the famous Red Flag (USAF) and Top Gun (US Navy) exercises at Nellis AFB, Nevada, and Miramar NAS, California, respectively. The feeling of realism for trainee aircrew ▶

Below: As an "Aggressor" training aircraft, the F-5E has proved to be ideal, providing front-line pilots in opposing aircraft with a taste of what the "other side" has to offer with regard to tactics. Aggressor crews fly and think Russian, and their aircraft, like the two shown here, are painted in representative camouflage colours.

is enhanced by the various Soviet-style camouflage schemes applied to the aircraft. USAF units equipped with F-5E/Fs are the 57th Fighter Weapons Wing, at Nellis AFB; the 405th TTW, at Luke AFB, Arizona; the 527th TFTAS, at RAF Alconbury, USAFE; and the 26th TFTS, at Clark AB, Philippines.

Right: Top Gun is the Navy Aggressor scheme at Miramar NAS, California, which is where this F-5E is based. The nose numbers are the same style as those carried by Soviet fighters.



Left: Sand and stone colours on this F-5E operated by the USAF Fighter Weapons School at Nellis AFB look garish until the aircraft begins to hunt for friendly prey over the desert ranges that surround the base.

The future of the F-5 design is now vested in the single-engined F-20 Tigershark development, although at the time of writing none had been ordered by the US services. Bearing a superficial resemblance to the E/F series, the F-20 is a far more capable aircraft, being powered by an 18,000lb (8,165kg) thrust GE F404 engine in a redesigned fuselage. The new aircraft carries more fuel, a pulse-Doppler radar matched to Sparrow or Sky Flash missiles, a bulged canopy for better pilot visibility and a flight performance increased by between 30 and 50 per cent. Despite the unfortunate loss of the first prototype in South Korea in October 1984, the F-20 programme continues, with a launch order hoped for during 1985.

Left: Two 20mm cannon project from the nose of a USAF F-5E; each gun has 280 rounds belt-fed from tanks in the lower part of the forward nose. Although the US forces use the E and two-seat F only for training, the many overseas operators fly the aircraft in their front-line squadrons to good effect.

Below: No company could have done more than Northrop to convince overseas air arms that the F-20 Tigershark is the future fighter for their needs but by early 1985, and after countless flight demonstrations, a launch customer had still to be found. Both the USAF and the Navy have stated publicly that they have no requirement for this privately funded export fighter, but Northrop still hope for foreign orders.

Rockwell B-1

B-1B

Origin: Rockwell International, North American Aerospace Operations, El Segundo, California.
Type: Strategic bomber and missile platform.
Engines: Four GE F101-GE-102 augmented turbofans each rated at 30,000lb (13,605kg) with full afterburner.
Dimensions: Span (fully spread) 136ft 8½in (41·67m), (fully swept to 67°) 78ft 2½in (23·84m); length 147ft (44·8m); wing area (spread, gross) 1,950 sq ft (181·2m²).
Weights: Empty over 160,000lb (72,576kg); max loaded 477,000lb (216,367kg).
Performance: Max speed at 36,000ft (10,970m) about 1,000mph (1,600km/h, Mach 1·5), at 500ft (150m) 750mph (1,205km/h, Mach 0·99); typical high-altitude cruising speed 620mph (1,000km/h); range with max internal fuel over 7,000 miles (11,265km); field length less than 4,500ft (1,372m).

Armament: Eight ALCM internal plus 14 external ; 24 SRAM internal plus 14 external; 12 B28 or B43 internal plus 8/14 external; 24 B61 or B83 internal plus 14 external; 84 Mk 82 internal plus 44 external.
History: First flight (B-1A) 23 December 1974, (B-1B) 18 October 1984; planned IOC 1 July 1987.
User: SAC.

Development: When the 96th Bomb Wing at Dyess AFB, Texas, received its first Rockwell B-1B in March 1985 there could have been few members of SAC who did not look on the drab shape and sigh with relief as they remembered President Carter's decision in 1977 to halt the B-1 programme, leaving the ageing B-52 and the none-too-plentiful FB-111 to promote America's manned bomber deterrent. That the B-1 survived and did not go the way of the XB-70 was due to a number of factors, chief among these being the need for a balanced strategic triad (manned bombers, ICBMs and submarine-launched ▶

Below: The first production Rockwell B-1B flew in October 1984, having been rolled out some six months ahead of schedule. The prototype camouflage scheme has been abandoned in favour of European 1.

missiles), neglected under Carter but nurtured by President Reagan. With the arrival of the B-1B, the USAF will be in the reassuring position of having one strategic bomber on the inventory (B-52), one in production (B-1B) and a third in development (ATB).

The B-1B is similar in shape to the four B-1A prototypes built in the 1970s, but under the skin it is a very different aeroplane, incorporating technical advances to ensure that it can penetrate Soviet airspace well into the 1990s. Two of the B-1As have been proving the modifications of the redesign, the second prototype being used for weapons and systems development and the fourth aircraft for defensive and offensive avionics testing. The crash of the second B-1A in August 1984 is unlikely to affect the programme to any great degree, according to Rockwell.

An increasing problem in developing modern attack aircraft is the signature (image) produced on defensive radars – hence the top-secret work on so-called "stealth" aircraft that is proceeding in the United States. The B-1B does not quite fall into that category, but extensive measures have been taken to reduce its radar cross-section. The angular exterior surfaces present on the original design have been smoothed and curved, the engine inlets have been modified, the wings have new rear fairings similar to those on the Tornado, and some 85 locations on the airframe, including the leading and trailing edges of the wings and tail surfaces, have received radar-absorbent coatings; even the

sharp angles in the cockpit have been rounded where possible. The result is that the B-1B has an RCS one-hundredth that of the B-52.

The electronic fit in the aircraft is just about the very best that American industry can provide. Eaton Corporation's AIL Division is the main contractor and it is largely on their expertise that the survivability of the aircraft over hostile territory will depend. The AN/ALQ-161 reprogrammable ECM system is the key to the B-1B's defence. This automatically detects and analyses radars that pick up the aircraft. A central computer then selects the appropriate countermeasure and applies it in the form of jamming signals. In addition, decoys and chaff can be ejected, tail warning radar will respond to incoming fighters or missiles, and flares can be fired to counter IR heat-seeking missiles.

In the nose is the Westinghouse APG-66 forward-looking and terrain-following radar which will take the B-1B down among the valleys and around the hills, all at less than 300ft (90m) above the ground. Inertial navigation will be ▶

Above: Prototype B-1B undergoing systems checks before being given its coat of camouflage and its ceremonial roll-out in late 1984. With this fully forward wing position, the aircraft will be able to make rapid take-offs to get away from SAC bases under threat from incoming missiles; fully swept, the wings will give the B-1B high subsonic speed at very low level to avoid searching enemy radars.

Left: Three of the four B-1A prototypes built in the early 1970s. Two of these aircraft participated in the development of the B version, particularly in systems and armament integration.

Below: Painted in a desert colour scheme which was not subsequently adopted for the B-1B, this original A bears a close resemblance to the new aircraft. However, the B-1B has more advanced electronics, different engine intakes and the ability to carry ALCMs externally under the fuselage as well as in the bomb bay.

used to ensure positioning accuracy and communications equipment will include a link to the USAF Satellite Communications system (AFSAT-COM); also included is the strategic Doppler radar and radar altimeter of the Offensive Avionics System (OAS) being installed in B-52s.

The original Mach 2 high-altitude dash performance of the B-1A has been dispensed with in the new aircraft; instead, a high-subsonic speed at low level has been planned, with a modest supersonic capability at cruise altitudes. The four electronically controlled F101-GE-102 turbofans each generate 30,000lb (13,600kg) of thrust, and the old variable-geometry inlets have been replaced by fixed inlets of a new design.

Inside the weapons bay, movable bulkheads allow a variety of stores to be accommodated, but the AGM-86B ALCM will be the principal armament of the new aircraft. SAC plans to have 100 B-1Bs operational by 1990, production being scheduled to run at four aircraft a month, starting in September 1986.

Below: The long dorsal spine on this B-1A prototype is not fitted to production B-1Bs. Engine intake geometry has also changed.

Above: The radar cross-section of the B-1B will be less than one-hundredth of that of a B-52. This A version displays its elevons.

Rockwell OV-10 Bronco

OV-10A, D

Origin: Rockwell International; designed and built at Columbus, Ohio, Division of North American Aircraft Operations (now Columbus plant of NAA Division).
Type: FAC aircraft.
Engines: Two 715ehp Garrett T76-416/417 turboprops.
Dimensions: Span 40ft (12·19m); length 41ft 7in (12·67m); wing area 291 sq ft (27·03m²).
Weights: Empty 6,893lb (3,127kg); loaded 9,908lb (4,494kg); overload 14,444lb (6,552kg).
Performance: Max speed (SL, clean) 281mph (452km/h); initial climb (normal weight) 2,600ft (790m)/min; service ceiling 24,000ft (7,316m); take-off run (normal weight) 740ft (226m); landing run, same; combat radius (max weapon load, low-level, no loiter) 228 miles (367km); ferry range 1,382 miles (2,224km).
Armament: Carried on five external attachments, one on centreline rated at 1,200lb (544kg) and four rated at 600lb (272kg) on short body sponsons which also house four 7·62mm M60 machine guns with 500 rounds each; (D) same, plus one three-barrelled 20mm GE M197 cannon in ventral turret.
History: First flight (YOV-10) 16 July 1965.
Users: TAC, PACAF, USAFE, USMC.

Development: A number of aircraft currently used by the US forces have their origins in the Vietnam War, a conflict which, under the tough operational rules prevailing, the Americans found to be unwinnable. The North American (later Rockwell) OV-10 Bronco was one design which answered the need for a rugged counter-insurgency aircraft which could deliver a modest amount of firepower against enemy troops, equipment and strong-points. As it turned out, the USAF modified the Bronco's role and it became a Forward Air Control aircraft, locating, identifying and marking Viet Cong targets for attack by tactical fighters. In this task the Bronco proved ideally suited, so much so that today it continues to operate in the FAC role.

The crew of two sit out in front of the wing and engines in the fuselage nacelle, enjoying a superb field of view, whilst the weapon carriage of up to

3,600lb (1,630kg) is more than adequate to supplement the firepower from the bigger jets. For self-defence, Sidewinder missiles can be carried on the Bronco's outboard underwing pylons. At the rear of the crew nacelle there is accommodation for five troops, two stretcher cases or cargo.

The USAF received 157 OV-10As, and many of these continue in service in West Germany with the 601st TACW at Sembach AB, in Hawaii with the 22nd TASS at Wheeler AB, and in the USA with TAC's 507th TACW at Shaw AFB. In a force upgrading, the OV-10s with the 22nd TASS replaced Cessna O-2As; the Broncos were themselves replaced in South Korea by the faster OA-37B.

The USMC also bought the Bronco for much the same role as did the USAF. A total of 114 aircraft were delivered, beginning in 1968, and 24 have been modified into sophisticated Night Observation Surveillance (NOS) machines under the designation OV-10D. Main changes include the addition of a FLIR sensor and laser target illuminator in a turret under a lengthened nose, and a remotely aimed 20mm turret beneath the fuselage.

Above: In silhouette, the OV-10 shape is quite distinctive: the Bronco is one of the world's few twin-boom service aircraft. The central crew nacelle has a rear door for loading freight, troops or stretchers.

Left: This OV-10 of the USAF, used for forward air control duties, wears the markings of the 51st TFW based at Osan AB, South Korea, but the unit has now traded its Broncos for faster OA-37s and the OV-10s have moved to the 22nd TASS in Hawaii, replacing Cessna O-2s.

Vought A-7 Corsair II

A-7D, E, K

Origin: Vought Corporation, Dallas, Texas.
Type: (D, E) Attack aircraft, (K) combat trainer.
Engines: (D, K) One 14,250lb (6,465kg) thrust Allison TF41-1 turbofan; (E) one 15,000lb (6,804kg) thrust Allison TF41-A-2.
Dimensions: Span 38ft 9in (11·8m); length (D, E) 46ft 1½in (14·06m); (K) 48ft 11½in (14·92m); wing area 375 sq ft (34·83m).
Weights: Empty (D) 19,781lb (8,972kg) (E) 18,942lb (8,592kg); loaded 42,000lb (19,050kg).
Performance: Max speed (D, clean, SL), 690mph (1,110km/h), (D, 5,000ft, 1,525m, with 12 Mk 82 bombs) 646mph (1,040km/h), (E, clean, SL) 693mph (1,115km/h), (E, 10,000ft, 3,050m, with 16 Mk 82 bombs) 562mph (904km/h); tactical radius (with unspecified weapon load at unspecified height) 715 miles (1,151km); ferry range (internal fuel) 2,281 miles (3,671km), (max with external tanks) 2,861 miles (4,604km).
Armament: One 20mm M61A-1 gun with 1,000 rounds; up to 15,000lb (6,804kg) of all tactical weapons on eight hardpoints (two on fuselage each rated 500lb, 227kg, two inboard wing pylons each 2,500lb 1,134kg, four outboard wing pylons each 3,500lb, 1,587kg).
History: First flight (A) 27 September 1965, (D) 26 September 1968, (E) 25 November 1968, (K) January 1981.
Users: TAC, ANG, USN.

Development: Like the Phantom, the A-7 Corsair II has operated with all three US air arms, the USAF, USN and USMC. Its parent was the F-8 Crusader, a larger and faster fighter aircraft but one which by the early 1970s was becoming obsolete in USN and USMC service. The A-7 is 8ft 6in (2·6m) shorter than the F-8, and its squat appearance has given rise to a number of affectionate epithets of which "Supersluf" ("Short Little Ugly Fella") and "Little Hummer" are the best known. It operates as a single-seat, subsonic fighter-bomber, and is capable of delivering a wide range of free-fall or guided ordnance with regularly proven accuracy using a weapon delivery system that works extremely effectively. In South-East Asia the A-7 achieved an outstanding attack capability

Above: An A-7B Corsair II pictured in 1973 and based aboard USS *Oriskany*. This variant offered an extra 850lb (385kg) of engine thrust over the clearly underpowered A-7A. When the more efficient E variant replaced the earlier types, the Navy pulled out a number of A-7Bs and converted them into TA-7C two-seat trainers.

which has remained with the aircraft ever since and has won for it a number of international bombing competitions in Europe and the USA.

The first of 199 A-7As was delivered to the US Navy in 1966, and the type formed the attack complement on board US fleet carriers until the arrival of the improved A-7B in 1968. The new variant incorporated a higher-powered engine, and 196 were delivered.

The USAF selected the A-7 to replace the F-100 Super Sabre and ordered 459 of the D variant which was specially tailored to suit the demands of the Air Force's low-level attack requirement. Among the changes incorporated in the D was a higher-powered engine (a licence-built Rolls-Royce Spey, designated ▶

Left: Snakeye retarded bombs tumble from a USAF A-7D of the 23rd TFW based at England AFB.

Below: A US Navy A-7E about to take the wire at the end of a sortie. The Corsair is being replaced by the F/A-18 Hornet in the USN.

Allison T41) and an in-flight refuelling capability to increase loiter time on bombing missions and for ferry flights. The D entered combat over Vietnam in October 1972 and a year later the type was switched from regular TAC squadrons to TAC-assigned units of the Air National Guard. Currently, A-7Ds operate with the 121st, 127th, 132nd and 140th TFWs and the 112th, 114th, 138th, 150th, 156th, 162nd, 178th, 180th, 185th and 192nd TFGs, based in eleven states and in Puerto Rico. As well as having a continuous-solution navigation and weapon-delivery system, plus an all-weather radar bombing capability, each of the 383 Ds has been fitted with a Pave Penny laser target-designator pod.

Closely resembling the D model, the A-7E is the Navy's present front-line version of the Corsair. It too has a TF41 engine and the same basic avionics, but it incorporates a retractable refuelling probe to match the Navy's drogue system

Below: USAF A-7K two-seat combat trainers undergoing maintenance at the Vought facility at Dallas, Texas. The K retains the wing fold mechanism incorporated for the Navy even though its need is rather academic for shore-based operations.

and specialised equipment for carrier operations. The E is used for close air support, tactical interdiction, sea search and surveillance and aerial tanking with the aid of the "buddy" system. Fitted with FLIR, the aircraft can identify and attack targets at night, and it was Navy Corsairs that provided valuable support for Marine units during the Lebanese Crisis and during the invasion of Grenada in 1983. Officially classed as a light attack aircraft, the A-7E equips squadrons on board twelve carriers.

To convert pilots on to the single-seat Corsairs, LTV proposed a two-seat version for the Navy designated TA-7C. Rebuilt from retired A-7As and Cs, the first of 65 examples flew in 1976 and incorporated the second seat in a modified front fuselage. This design proved a success and the USAF followed suit (but considerably later) with the A-7K. The first of these was delivered in 1981, and the 31 aircraft built were issued at the rate of one per ANG squadron plus 18 for the 162nd TFTG in Tucson, Arizona.

Two overseas air forces operate the Corsair II: Greece, with nearly 60 A-7Hs (which are similar to USAF A-7Ds); and Portugal, with 20 A-7Ps (modernised Navy A-7As) plus 30 more on order.

Weapons

A multi-million dollar industry, the American arms-producing organisation is a vital factor in the maintenance of US defensive and offensive forces. The basic air weapon is still the gun. Considered obsolete in the late 1950s, when euphoria over the advent of guided missiles abounded, this form of airborne armament came back with a vengeance less than ten years later in Vietnam. Today most US service aircraft have a built-in gun, usually a 20mm M61 with a high rate of fire and of the multi-barrel Gatling type. Podded guns, favoured in the 1960s when jets arrived with no provision for a built-in armament, are not usually carried as they confer unacceptable drag penalties on performance and, more especially, reduce valuable pylon space for offensive weapon loads on attack aircraft.

Supplementing the guns are air-to-air radar and infra-red guided missiles, which have a far greater degree of reliability than those used even a few years ago. In general, radar-guided missiles utilise the aircraft's own radar for tracking and lock-on to a target, whilst the IR types seek a heat source from the target aircraft.

Air-to-ground ordnance is a much wider subject, encompassing free-fall conventional and nuclear bombs, laser-guided bombs and missiles, anti-radar weapons, and optical and radar-guided missiles. Within the AGM field come weapons such as the SRAM and the more controversial Cruise.

Guns

M61A1 Vulcan 20mm cannon

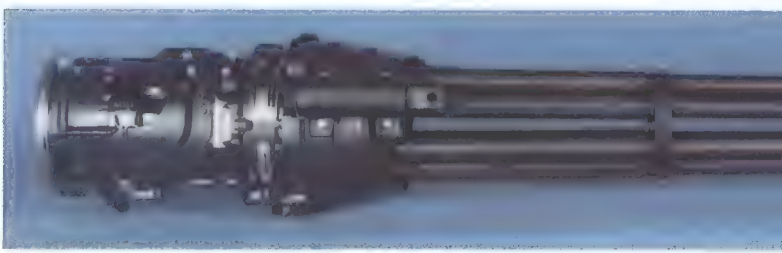
Produced by General Electric, the famous Vulcan six-barrel gun equips most of America's front-line fighters, and has done so for nearly 25 years. It is drum-fed and usually employs linkless ammunition. Maximum rate of fire is 6,600 high-velocity rounds per minute, although no aircraft carries that many shells in normal circumstances. Aircraft using the M61 include the A-7, F-4, F-14, F-15, F-16, F-18, F-104 and F-111, whilst the T-171 is the version fitted to the rear remote-controlled position in the B-52H. The podded versions of the Vulcan are designated SUU-16/A and SUU-23/A, which differ in detail but have the same performance.

GAU-12/U 25mm cannon

Unique to the AV-8B Harrier II, this recent GE-developed gun is fitted in the port ventral pod and fed from the starboard pod which carries 300 rounds of linkless ammunition. A five-barrel weapon, it fires the Bushmaster family of ammunition which includes HE, incendiary and armour-piercing rounds. Rate of fire is approximately 3,600 rounds per minute.

GAU-8/A Avenger 30mm cannon

With a length of 21ft (6·4m) without the magazine drum and a round which is larger than the normal 30mm shell, this gun is the most powerful weapon of its kind now flying. Projecting menacingly from the nose of the A-10A Thunderbolt, the GAU-8/A can fire depleted uranium-tipped, armour-piercing rounds

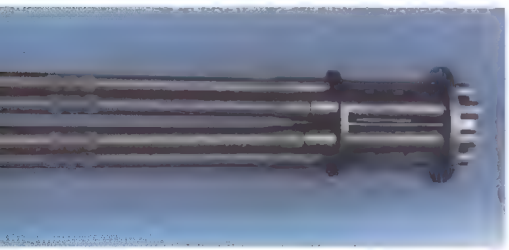


Above: "Don't complain Mac — just push!" This cumbersome but necessary item of equipment is the Ammunition Loading System for the A-10's GAU-8/A 30mm cannon. Although it is the only specialised piece of ground equipment used by the A-10, such a system restricts operations to the aircraft's main bases or, in Europe, the Forward Operating Locations (FOLs). The system can be loaded in under 13 minutes.

at a rate of 2,000 or 4,000 per minute from its seven barrels. The shells are fed from a large drum in the body of the fuselage via a winding conveyor system, the drum accommodating 1,174 rounds of linkless ammunition.

M39 20mm cannon

This single barrel revolver-feed weapon arms the F-5E, two being located above the nose in front of the cockpit. Each gun has 280 rounds and a relatively low rate of fire. ▶



Left: Reliability of the M61A1 Vulcan cannon in USAF service is good, with an average stoppage rate of just one round in 10,000. The weapon's six barrels rotate anti-clockwise, pumping out a maximum of 100 rounds/min.

Air-to-Air Missiles

AIM-7 Sparrow

The AIM-7F is currently the most widely used version of this medium-range, all-weather, semi-active radar guided missile. It has a reach of some 62 miles (100km) and has shown itself to be capable of performing well in combat. The latest production variant is the AIM-7M, which has the same external dimensions and appearance as the F but features a monopulse seeker head which provides better performance in natural clutter and ECM. Length 12ft (3·66m); warhead 88lb (40kg).

AIM-9 Sidewinder

Undoubtedly one of the great missile designs of all time, Sidewinder is now in its third decade of service with the US forces. Such is its success that the basic design was copied by the Soviet Union as the K-13, codenamed AA-2 Atoll by the West. AIM-9L can be fired from almost any angle at a target, as successfully demonstrated by British Sea Harriers during the Falklands War. The L is recognisable by the "double delta" control fins compared with the triangular shape on earlier versions. The improved-performance AIM-9M is now in production and service. Length (L) 112·2in (2·85m); range 11 miles (17·7km).

Above: The superb Sidewinder — in this case an AIM-9L (identfiable by the long-span canard fins). This groundcrewman is removing one of the safety tags from the missile prior to flight.

AIM-54 Phoenix

Developed by Hughes for use with the F-14A Tomcat, the Phoenix has a range of some 130 miles (209km) and is a "fire-and-forget" radar guided missile. Using Tomcat's advanced AWG-9 radar, six Phoenix can be fired near-simultaneously against six different targets. The solid fuel motor gives the missile a speed to burnout of Mach 3·8. The latest variant is the AIM-54C, which has an improved target detecting device and an enhanced ECCM capability. Length 157·8in (4·01m); warhead 132lb (60kg).

AIM-4 Super Falcon

Claimed to be the first guided AA missile in the world to enter operational service, the Falcon was developed by Hughes Aircraft in the late 1940s. The AIM-4E Super Falcon was designed to arm the F-106A Delta Dart and appeared in

Above: A few AIR-2A Genie nuclear rockets still equip ADTAC F-106 Delta Darts. The fins have flick-out extensions for stability.

1958, whilst the later AIM-26B replaced the E and still arms the remaining Darts. The missile uses semi-active radar homing and has a range of six miles (9·7km). Length 81·5in (2·07m).

AIR-2A Genie
Production of this old unguided rocket ceased in 1962, but in updated form it still arms F-106As and because of its nuclear warhead it can claim to be the world's most powerful AA missile. A Thiokol motor of 36,660lb (16,602kg) thrust propels the rocket to a distance some 1,000ft (300m) from the target, when the 1·5kT warhead is triggered. Length 9·6ft (2·94m); range 6·2 miles (10km).

AIM-120 AMRAAM
The new "fire-and-forget" Advanced Medium-Range Air-to-Air Missile is under development to replace Sparrow. It is the same length as its predecessor (146in, 3·7m), but weighs less and has an extended performance envelope. An advanced guidance system eliminates the need for the fighter's radar to illuminate the target, and the launch aircraft can immediately turn round after firing AMRAAM knowing that the missile will continue unerringly on course at Mach 4. First guided launch October 1981; service from 1985–86. ▶

Below: One of the 94 initial test rounds of AMRAAM on an F-14A Tomcat. Orders for this missile are expected to total thousands.

Above: A full-size model of the USAF's ASAT missile ready for loading on an F-15A at Boeing's Seattle facility in August 1982.

ASAT

The Air-Launched Anti-Satellite weapon, under development by Vought and Boeing, is a missile capable of destroying enemy satellites in orbit. Using a solid-propellant rocket motor, it is launched in a zoom climb from an F-15, the miniature homing vehicle being capable of reaching targets at heights up to 620 miles (1,000km). Two squadrons of F-15s at Langley and McChord AFBs will carry the weapon from 1987.

Air-to-Ground Weapons (Unpowered)

AGM-62 Walleye

An unpowered glide bomb with TV guidance, Walleye has been produced in three versions – I, II and Extended-Range Data-Link – and is in service with the USAF and US Navy/Marines. Once launched with the missile TV camera locked on to the target, the carrier aircraft can depart from the area leaving the bomb to do the rest. Length (II) 13·2ft (4·04m); range (II) 35 miles (56·3km).

Paveway

Paveway laser-guided bombs were first used during the Vietnam War, providing

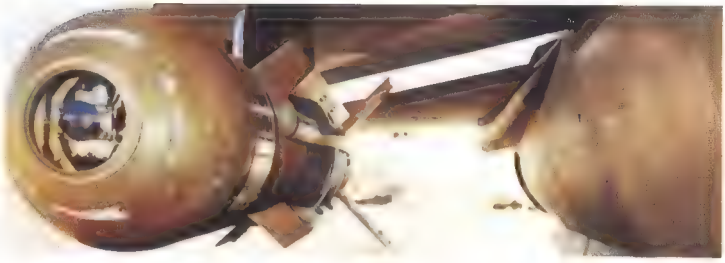
Right: Walleye 1 on test under an A-7 at China Lake in 1969. Most of the present rounds are Extended Range Data-Link type.

precision weapon delivery against a wide variety of targets. Using as a basis a standard 500lb (225kg), 1,000lb (450kg) or 2,000lb (900kg) "iron" bomb, Paveway incorporates a guidance head with movable fins. The energy from the laser-illuminated target is reflected and detected by the laser guidance head, which computes appropriate commands to the movable surfaces and thus influences the trajectory of the bomb and steers it to the target. Following the initial Paveway I, the more advanced Paveway II entered service in 1978 with the USAF and US Navy, equipping all the principal attack aircraft. Folding rear wings are also a feature of the II series, which are designated GBU-10 Mk 84 2,000lb (900kg), GBU-12 Mk 82 500lb (225kg), and GBU-16 Mk 83 1,000lb (450kg). Paveway III was developed in 1980-81 and is a version designed for low-altitude delivery and having a modest stand-off capability. Improvements include high-lift folding wings and a better scanning seeker. Texas Instruments produce the laser guidance kit.

GBU-15 Cruciform Wing Weapon
A precision-guided glide bomb, the GBU-15 is in current USAF service and comprises a Mk 84 2,000lb (900kg) general-purpose bomb equipped with a TV-guidance seeker and data link. It is designed for use against targets such as railways, buildings and bridges. Two aircraft using the bomb are the F-4 and F-111. The kit can also be fitted to the M118 3,000lb (1,360kg) bomb and the SUU-54 bomblet dispenser, which is designed for operations against larger area targets. A powered version of the GBU-15, designated AGM-130, is being developed; this will have a range of some 15 miles (24km) and a submunition or unitary warhead.

HOBOS (Homing Bomb System)
This is an electro-optically guided bomb used by USAF tactical aircraft such as the F-16 and A-10, for attacking high-value targets. Like the GBU-15, HOBOS utilises a Mk 84 2,000lb (900kg) or an M118 3,000lb (1,360kg) bomb. ▶

Left: Although the B-52D in the background has now left the scene, the olive drab slicks on the low-loader remain standard weapons with the US air forces. The pick-up points on each bomb are to a common size and enable almost any NATO-operated aircraft to lift this type of weapon from any airfield which holds stocks.



Above: HOBOS (Homing Bomb System) on an F-111 pylon.

Right: An AGM-86B ALCM drops from the wing pylon of a B-52G over the White Sands missile range during tests in October 1982.

Rockeye Mk 20 Cluster Bomb
Developed by the US Navy in the mid-1960s, this 500lb (225kg) weapon releases 247 fragmentation bomblets. A laser-homing version is in service with a KMU-420 guidance package, and a dispenser called APAM (Anti-Personnel/Anti-Material) is in use but with 717 bomblets.

Snakeye Mk 82
The petal airbrakes are a distinctive feature of this high-drag 500lb (225kg) "iron" bomb; without the retarding system, the weapon becomes a "slick" low-drag bomb. A laser head can be fitted.

Durandal
This French (Matra-designed) anti-runway weapons system was selected by the USAF in September 1983 and since then many thousands have been delivered for use with F-4 and F-111 tactical aircraft. Low-level release is followed by deployment of a retarding parachute, rocket acceleration and penetration into the runway, with instant detonation or time delay.

CBU-55 Fuel-Air Explosive Weapon
The principle of the FAE weapon is the creation of a cloud of fuel-air mixture which is then detonated to achieve an explosive affect. Both the USAF and the Navy have these weapons in service, in order to clear large areas of mines, booby traps, etc. One example is the CBU-55, which weighs 500lb (225kg) and comprises three canisters of fuel which separate after dropping, to produce a high blast overpressure when ignited.

LAU-32 Rocket Pod
Various types of pods carrying a number of unguided rockets are used by the US forces. The LAU-32 contains nineteen rockets and the LAU-10 has three 5in (127mm) Zuni rockets.

Nuclear bombs
There are a number of nuclear bombs in service carried by the main types of tactical and strategic aircraft. The B28 is a free-fall weapon deployed by the B-52 (up to eight), A-6 (three) and B-1B (up to twenty), and the B43 is tactical/strategic, retarded or free fall. The B61 is similar to the -43 but has yields in the 100–500kT range; up to 38 can be carried by the B-1B. Nuclear warheads for a range of missiles are given "W" prefixes, for example W72 for Walleye and W80-1 for the head of the AGM-86B ALCM.

Right: Devoid of the usual wing pylons, this FB-111A bomber carries a SRAM in its bomb bay. The first dummy missile was dropped from a B-52 in December 1967 and the weapon became operational early in 1972. Up to six SRAMs can be carried by the FB-111A.

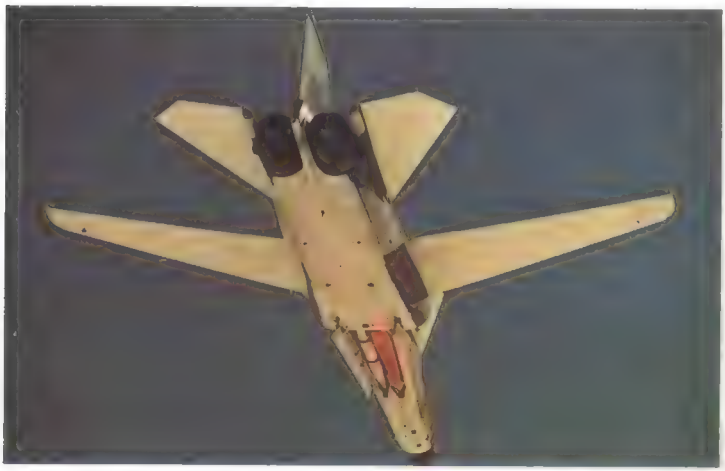
Air-to-Ground Missiles

AGM-86B Air-Launched Cruise Missile

This emotive weapon is now in service with Strategic Air Command B-52Gs and will also form the main strike missile for the B-1B. Whether nestling on underwing pylons on B-52s or located on rotary launchers in the large bays of B-1Bs, the ALCM represents a major step forward in strategic warfare. Powered to high subsonic speeds by a small Williams 600lb (272kg) thrust turbofan, the AGM-86B will terrain-hug from launch-point to a target up to 1,550 miles (2,500km) distant. The missile, produced by Boeing, will undergo updates to maintain its capability. Studies are under way to develop an advanced cruise missile to replace the AGM-86B from the late 1980s; General Dynamics is the main contractor.

AGM-69 Short-Range Attack Missile

SRAM is a supersonic air-to-surface nuclear missile carried by the B-52G/H (twenty missiles) and FB-111A (six). With a warhead yielding 200kT, SRAM has a range of between 35 and 105 miles (56–169km) depending on the attack profile (semi-ballistic, terrain-following, pull-up followed by a dive on target, or ▶



Above: An expensive weapon load for an F/A-18A Hornet — four anti-ship Harpoons, two Sidewinders and two Sparrow AAMs.

combined inertial and terrain-following). A total of 1,500 missiles have been built. Length 14ft (4·27m); weight 2,230lb (1,012kg).

AGM-84 Harpoon
This anti-ship missile, developed from the submarine- and ship-launched version, is in service with US Navy P-3 Orion and S-3 Viking patrol squadrons and is compatible with the A-6 and F/A-18. USAF B-52Gs will carry up to twelve Harpoons in support of Navy anti-surface warfare operations. Length 12·6ft (3·84m); range approximately 68 miles (109km).

AGM-65 Maverick
The optically guided Maverick forms the main anti-armour ordnance of the USAF A-10A, and the Navy/Marine A-4 and A-7 tactical aircraft. Guidance differs with variant — TV for the AGM-65A/B, imaging IR for the D/F models and laser for the E model. The basic 125lb (57kg) warhead has a shaped charge, whilst the 300lb (136kg) warhead is for anti-ship use. Length 8·05ft (2·46m); range approximately 14 miles (22·5km).

Below: An AGM-65B Scene-Magnification Maverick being prepared for loading on to an A-10A Thunderbolt II. Note the optical seeker head.

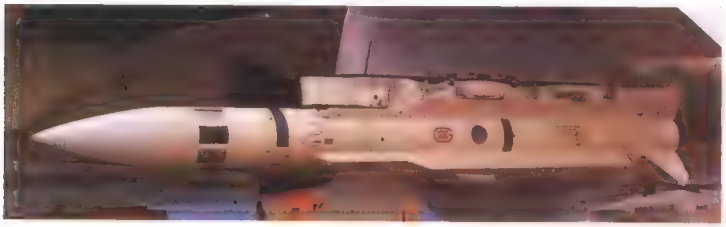
AGM-88 HARM
The AGM-88 High-speed Anti-Radiation Missile is planned to replace the existing Shrike and Standard ARM. The Navy will fly the weapon on A-7s, A-6s and F/A-18s, whilst the USAF will use Wild Weasel F-4s and EF-111s. HARM can be used when the launch aircraft is threatened, when radar emitters are detected, or when only part of a radar system is functioning. Length 13·8ft (4·17m); range over 11·5 miles (18·5km).

AGM-45 Shrike
Initially used in Vietnam with disappointing results, Shrike has been updated and serves with the US Navy/Marines (A-4, A-6, A-7, F/A-18) and USAF (F-4). The missile homes in on ground defence radars using specially tailored seeker heads. Being replaced by HARM. Length 10ft (3·05m); range 18–25 miles (29–40km).

AGM-78 Standard ARM
Developed from the Standard ship-to-air missile, the AGM-78 was one of the main anti-radiation weapons used by the F-105 Wild Weasel Thunderchiefs until their withdrawal from service. It can be carried by the F-4G replacement, but will shortly be replaced by the later HARM missile. Length 15ft (4·57m); range 35 miles (56·3km).

AGM-123 Skipper
This weapon is basically a powered 1,000lb (450kg) bomb fitted with a Shrike rocket motor. It is intended to operate in the anti-shipping role and has a limited stand-off capability.

Below: Standard ARM was developed in the 1960s and was used in Vietnam. It still arms the F-4G, but will be replaced by HARM.



Below: Based in part on the Sparrow AAM, the Shrike is a passive homing anti-radiation missile, also due for replacement by HARM.

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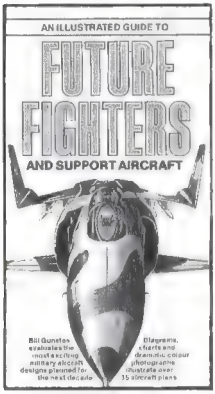

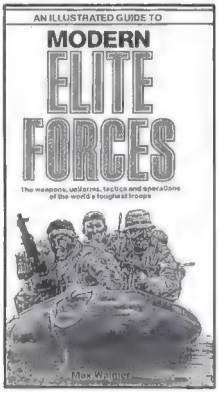

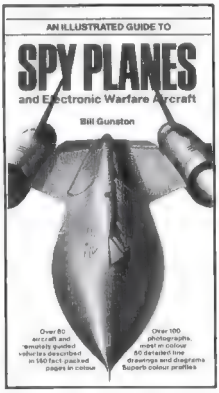

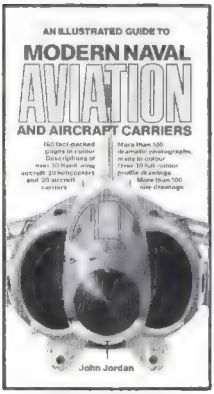

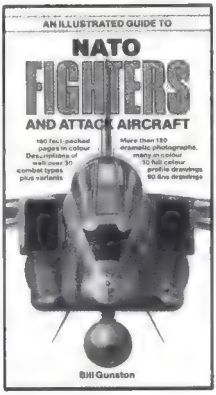

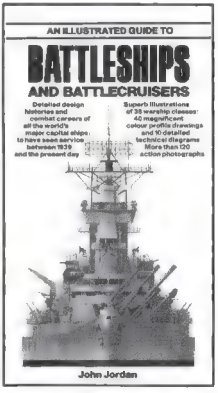

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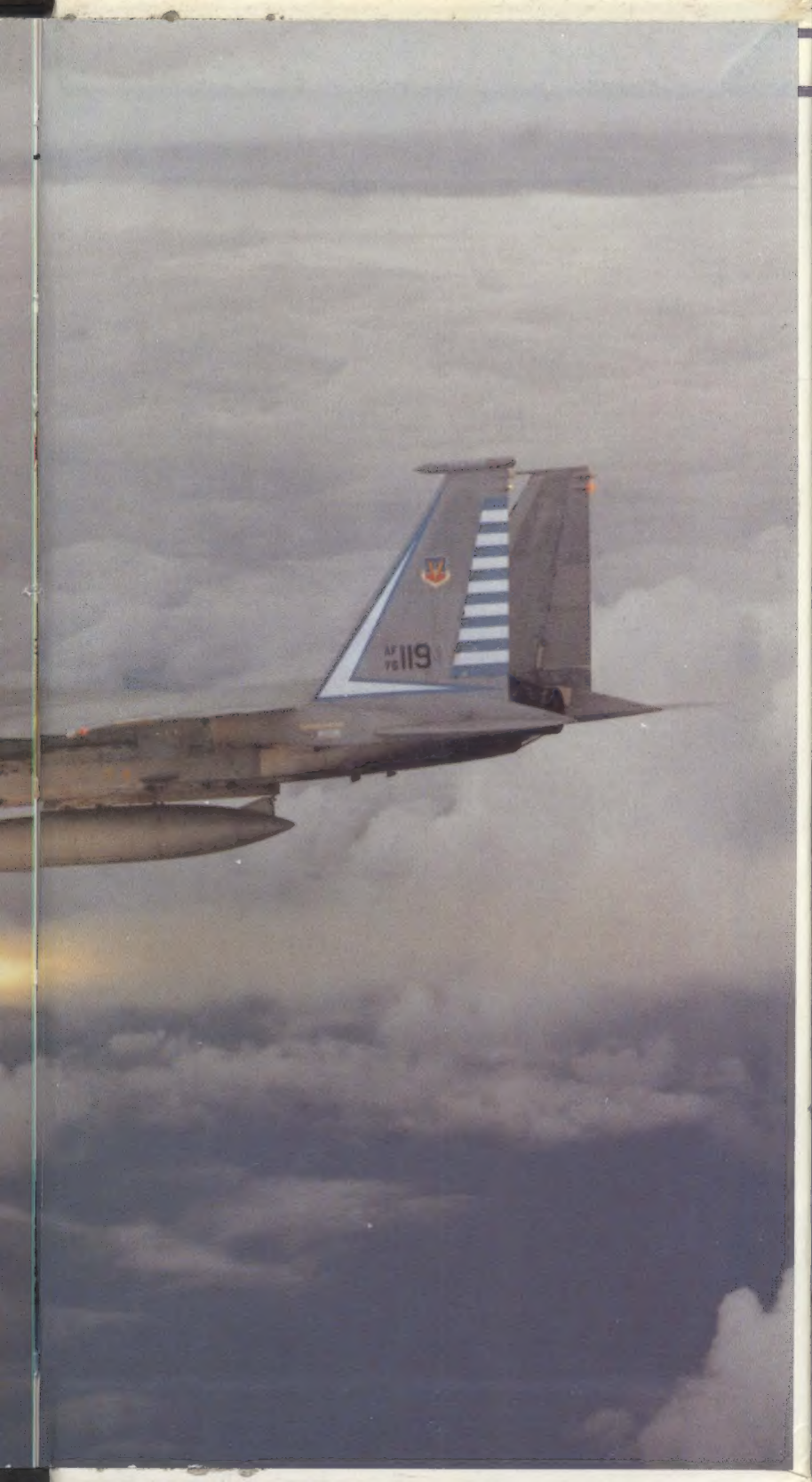
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